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INTENSIVE EVALUATION AND MONITORING OF CHINOOK SALMON AND STEELHEAD TROUT PRODUCTION, CROOKED RIVER AND UPPER SALMON RIVER SITES

Annual Progress Report
Period Covered: January 1, 1992 - December 3 1, 1992

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ABSTRACT

The purpose of this intensive monitoring project is to determine the number of returning chinook salmon Oncorhvnchus tshawvtscha and steelhead trout O. mvkiss adults necessary to achieve optimal smolt production, and develop mitigation accounting based on increases in smolt production. Two locations in Idaho are being intensively studied to meet these objectives. Information from this research will be applied to parr monitoring streams statewide to develop escapement objectives and determine success of habitat enhancement projects.

Major findings of the project to date are:

1. The peak period of arrival at Lower Granite dam for upper Salmon River wild/natural spring chinook salmon smolts is later than the peak of the total spring chinook salmon smolt run at Lower Granite Dam. This timing difference is a reault of the earlier arrival of hatchery smolte, which greatly outnumber the wild/natural smolts. During all years studied (1988-1992), peaks in arrival of wild/natural spring chinook salmon smolts at Lower Granite Dam corresponded with peaks of flows measured at Lower Granite Dam. National Marine Fisheries Service data from passive integrated transponder (PIT) tagged wild Middle Fork Salmon River spring chinook salmon also support this finding (Mathews et al. 1993). We suggest flow characteristics at Lower Granite Dam directly influence wild/natural spring chinook salmon smolt movement through Lower Granite pool.

2. Estimates of chinook salmon egg-to-parr survival rates from natural spawners and adult outplants in the headwaters streams of the upper Salmon River for brood years 1987-1991 averaged 24.0% (90% C.I.; 12.3%-38.2%).

3. Migratory year 1988 to 1992 estimates of upper Salmon River wild/natural parr-to-smolt (at the onset of smolt migration) survival averaged 18.7% (90% C.I.; 17.2%-20.1%) for chinook salmon and 22.8% (90% C.I.; 11.9%-49.5%) for age 2+ and older steelhead trout. Migratory year 1991 to 1992 estimates of Crooked River wild/natural parr-to-smolt (at the onset of spring migration) survival average 33.6% (90% C.I.; 26.9%-40.9%) for chinook salmon and 47.6% (90% C.I.; 43.4%-54.5%) for age 2+ and older steelhead trout.

4. Age 2+ and older eteelhead trout parr-to-smolt (at the onset of spring migration) survival rates have declined dramatically the past three years in the upper Salmon River, from an average of 51.4% for migratory years 1988 and 1989 to an average of 16.4% for migratory years 1990-1992.

5. We estimated that 10.9% of the age 1+ and 45.5% of the age 2+ pre-fishing season steelhead trout populations in Crooked River were fishing mortalities in 1992.

6. Delayed mortality of chinook salmon parr PIT tagged in August and returned to their natural rearing habitat was not significantly higher than un-handled chinook salmon parr over a 2-month period.

7. Complex habitat rehabilitation structures in the upper meadow section of Crooked River increased the summer carrying capacity for age 1+ steelhead trout while simple sill log structures did not.

Other findings of this project are:

1. In smaller spawning streams a total ground count of redds just after the peak of spawning can accurately estimate chinook salmon female escapement with an assumed female to redd ratio of 1:1.

2. Habitat improvement structures can provide clean gravel that attracts chinook salmon spawners.

3. Chinook salmon and steelhead trout juveniles generally key in on the same stimuli for emigration. Increases in discharge (especially associated with storm events) being the primary stimulus in the spring, and sharp drops in water temperature and/or storm events being the primary stimuli in the fall.

4. Higher elevation (harsher climate) streams will have a higher percentage of parr emigrate in the fall. Approximate equal percentages of age 0 chinook salmon and age 2+ and older steelhead trout will emigrate from a particular stream.

5. Low gradient headwater tributary stream sections in the upper Salmon River have an estimated two-three times greater egg-to-parr survival than in the mainstem Salmon River near these tributary streams. Irrigation diversions on Fourth of July, Champion, Fisher, Williams, and Beaver creeks block adult chinook salmon access to low gradient sections of these streams.

6. PIT tag detections indicate the smolt guidance system at Lower Granite Dam is not efficient at guiding sockeye salmon O. nerka smolts away from the turbines and into the collection facility.

INTRODUCTION

Project 83-7 was established under the Northwest Power Planning Council's 1982 Fish and Wildlife Program, Measure 704 (d)(l) to monitor natural production of anadromous fish, evaluate Bonneville Power Administration (BPA) habitat improvement projects and develop a credit record for off-site mitigation projects in Idaho. Project 83-7 is divided into two sub-projects: general and intensive monitoring. Results of the intensive monitoring sub-project are reported here. Results from the general monitoring sub-project will be reported in a separate document (Rich et al. 1993). Field work for the intensive monitoring sub-project began in 1987 in the upper Salmon River and Crooked River (South Fork Clearwater River tributary) study areas.

The goals of the intensive monitoring sub-project are to provide escapement objectives for wild/natural anadromous stocksthatwilloptimize smoltproduction and provide mitigation accounting based on increases in smolt production. Our approach to determine escapement needs for wild/natural anadromous stocks is: (1) to estimate egg deposition using weir counts, redd counts, and carcass surveys; (2) use snorkel counts and stratified random sampling to estimate parr abundance and egg-to-parr survival; (3) Passive Integrated Transponder (PIT) tag representative groups of parr and use PIT tag detections at the lower Snake and Columbia rivers' smolt collecting dams to estimate parr-to-smolt survival; and (4) use adult outplants into tributary streams to estimate carrying capacity. Our approach to mitigation accounting based on increases in smolt production is: (1) to estimate parr production attributable to habitat projects; (2) to quantify relationships between spawning escapement, part production, and smoltproduction; and '(3) use smolt production as a basis for assessing habitat improvement benefits.

OBJECTIVES

The objectives of this project are to determine:

1. The mathematical relationship between spawning escapement, parr production, and smolt production;

2. Carrying capacity and optimal smolt production; and

3. Habitat factors relating to substrate, riparian, and channel quality that limit natural smolt production.

STUDY AREAS

Upper Salmon River

The Salmon River originates in the Sawtooth, Smokey, and White Cloud mountains in south central Idaho (Figure 1). The upper Salmon River study site is the entire Salmon River drainage upstream of the Sawtooth Fish Hatchery weir at elevations above 1,980 m. Study sections are located throughout the upper basin. The river above Sawtooth Fish Hatchery is a major production area for spring chinook salmon Oncorhvnchus tshawvtscha and A-run summer steelhead trout O. mvkiss. Other resident salmonids in the upper Salmon River drainage are native rainbow trout O. mvkiss, cutthroat trout O. clarki, bull trout Salvelinus malma, mountain whitefish Prosopium williamsoni, and non-native brook trout S. fontinalis (Mallet 1974).

Historically, sockeye salmon O. nerka existed in all moraine lakes in the Stanley Basin (Everman 1895). An extremely depressed remnant run of sockeye salmon returns to Redfish Lake. The outlet of Redfish Lake enters the Salmon River approximately 2.7 km downstream from Sawtooth Fish Hatchery. Occasionally, adult sockeye salmon have been seen in Alturas Lake Creek (K. Ball, Idaho Department of Fish and Game [IDFG], personal communication), but an irrigation diversion that completely dewaters the creek every summer makes adult passage to the lake unlikely (Bowles and Cochnauer 1984). No other sockeye salmon runs are known to exist in the Salmon River drainage.

Nearly pristine water quality and an abundance of high quality spawning gravel and rearing habitat is present throughout much of the upper basin. Water flows at the Sawtooth Fish Hatchery range from lows of 1.73-3.46 m^3/s from July through April to highs of 11.2-23.3 m^3/s during May and June. Conductivity in the upper Salmon River drainage ranges from 37-218 mhos/cm (Emmett 1975).

Livestock grazing and hay production are the predominant uses of private land throughout the upper Salmon River basin. In localized areas, grazing within riparian zones has degraded aquatic habitat. Additionally, diversion of water from the river and its tributaries has impaired the production potential for chinook salmon and steelhead trout. In an average flow year, the Busterback diversion between Alturas Lake Creek and Pole Creek completely dewaters the river for approximately 3 km from July through September. Flow diversion from other tributary streams varies from partial to complete dewatering. Four major tributary creeks in the upper Salmon River (Fourth of July, Champion, Fisher, and Beaver creeks) are completely dewatered on their lower ends during the summer and early fall.

In 1982, a water user along Pole Creek converted from flood irrigation to overhead sprinkler irrigation. This has decreased the withdrawal of water from Pole Creek. In 1983, the BPA funded the construction of a fish screen for the Pole Creek irrigation diversion. From 1985 to 1989, steelhead trout fry were outplanted into upper Pole Creek (IDFG, unpublished data). Additionally, as part of this project's research, adult chinook salmon have been outplanted into Pole Creek since 1988 and adult steelhead trout were outplanted in 1991.

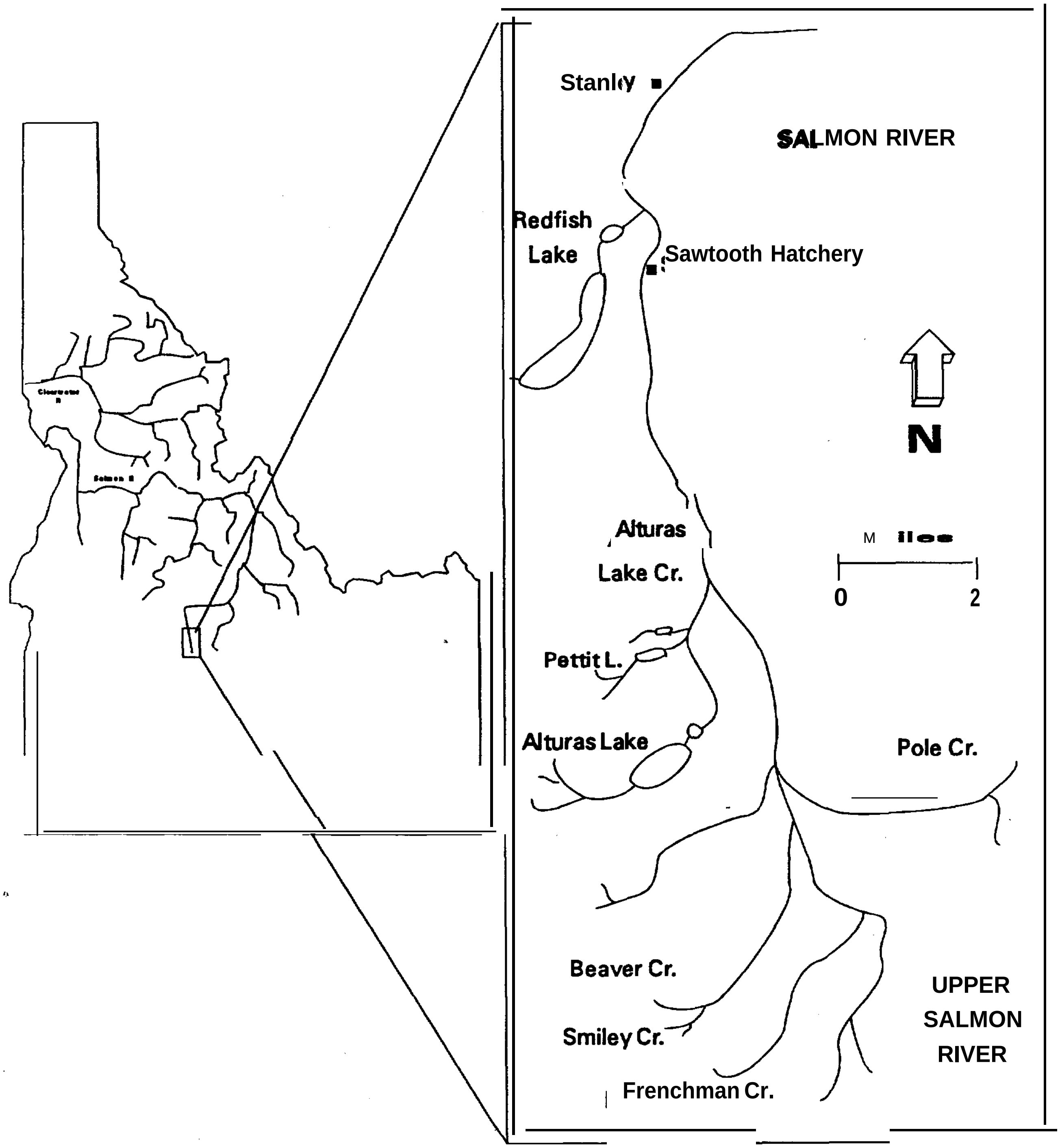

Figure 1. Location of upper Salmon River study area.

The Sawtooth Fish Hatchery was constructed in cooperation with the U.S. Fish and Wildlife Service and the U.S. Army Corps of Engineers through the Lower Snake River Compensation Plan. The hatchery program involves trapping adult chinook and steelhead trout and releasing smolts and other life stages. The hatchery is designed to produce 2.4 million chinook smolts per year. Eyed steelhead trout eggs are sent to other facilities for rearing. The smolts are transported back to Sawtooth Fish Hatchery for release. The objective is to release 4.5 million steelhead trout smolts at Sawtooth Fish Hatchery. At least 33% of the adult chinook and steelhead trout entering the trap are released upstream of the hatchery to spawn naturally.

Crooked River

Crooked River originates at an elevation of 2,070 m in the Clearwater Mountains within the Nez Perce National Forest and enters the South Fork Clearwater River at river kilometer 94 at an elevation of 1,140 m (Figure 2). The study area includes the entire Crooked River drainage. Historical chinook salmon and steelhead trout runs were eliminated in 1927 by the construction of Harpster Dam on the South Fork Clearwater River. Following removal of the dam in 1962, spring chinook salmon and B-run summer steelhead trout were reestablished in Crooked River. Other resident salmonids in the Crooked River drainage are native rainbow trout, cutthroat trout, bull trout, mountain whitefish, and non-native brook trout (Petrosky and Holubetz 1986). Measured flows on Crooked River from March 14, 1991 through may 9, 1991 ranged from 5.68-0.444 m^3/s. Conductivity ranges from 29-39 μmhos/cm in flowing sections and 38-51 μmhos/cm in ponds (Mann and Von Lindern 1987).

During the 19505, dredge mining activities severely degraded habitat within the two meadow reaches of the stream. In the upstream meadow reach, the stream was forced to the outside of the floodplain. This resulted in a mostly straight, high gradient channel. In the lower meadow reach, dredge tailings have forced the stream into long meanders with many ponds and sloughs. During runoff, juvenile trout and salmon use some of these ponds, but they are trapped as flows recede.

Fish density and habitat surveys were initiated in 1984 by IDFG and the Intermountain Forest and Range Experiment Station, U.S. Forest Service (USFS), Boise, Idaho. Petrosky and Holubetz (1985) found that densities of juvenile chinook salmon and steelhead trout in the two meadow reaches were lower than in other Idaho streams. Densities of fish in the pools and high velocity sections were similar to each other. Since chinook salmon parr generally prefer pool habitat over high velocity sections, this lack of a relationship between juvenile density and habitat type indicates that the upper meadow reach was under seeded in 1984. In 1984, in an effort to compensate for stream gradient and to increase the pool to riffle ratio, the USFS, with BPA funds, placed a series of log structures, rock and boulder deflectors, organic debris structures, and loose rock weirs in the upper meadow stream section. In addition, streambanks were stabilized and revegetated, an off-channel pond was connected with a side channel, and a culvert blocking adult passage was removed (Hair and Stowell 1986). Recent efforts have concentrated on connecting additional ponds in the dredge tailings to the main channel and developing side channels to provide continuous water supply during low flow periods.

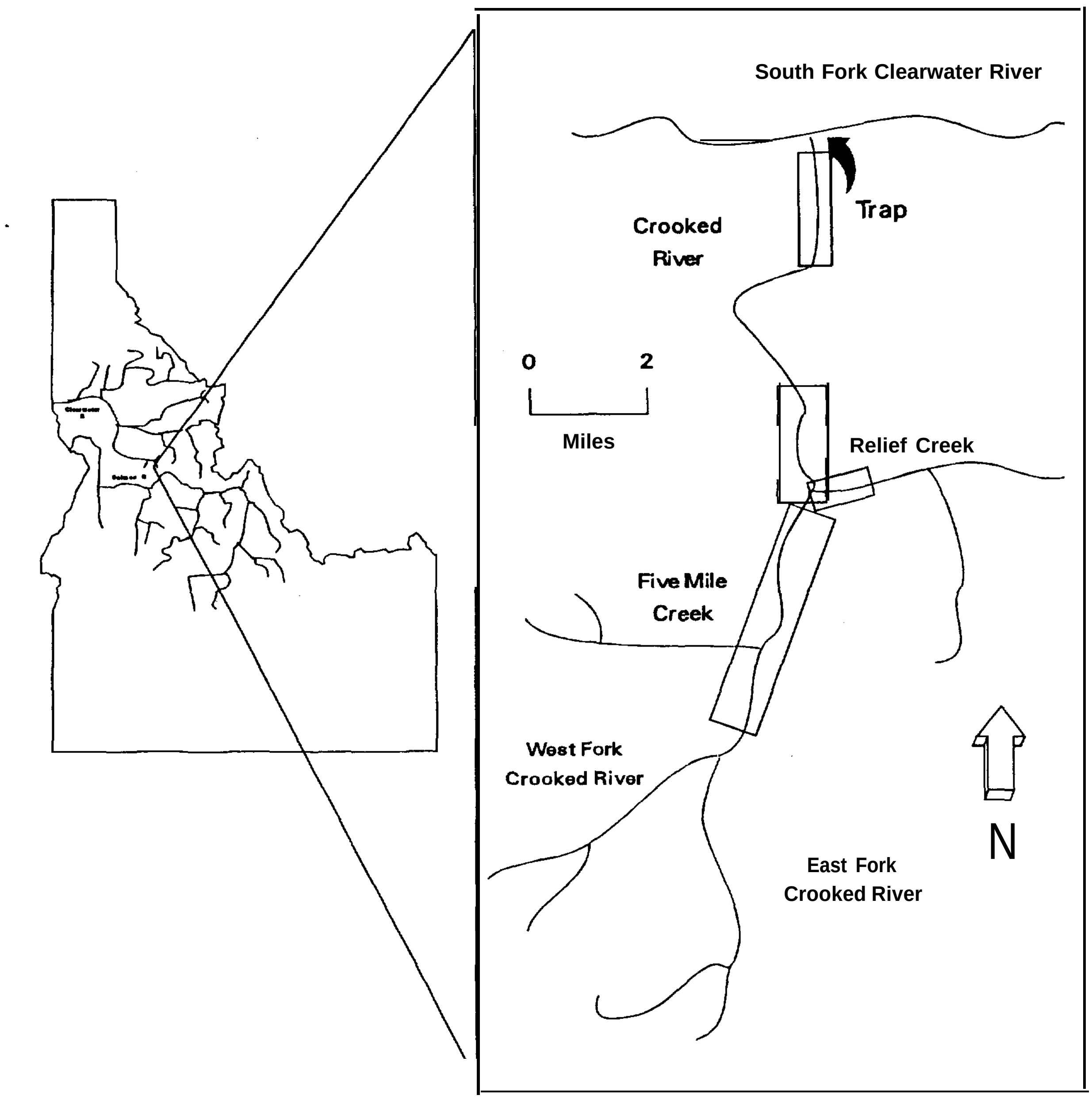

Figure 2. Location of Crooked River study area. Meadow sections degraded by dredge mining are boxed.

Challis

After the Salmon River flows past the Sawtooth Fish Hatchery area, it continues to travel in a north and east direction. About 118-144 km downstream of Sawtooth Fish Hatchery, the river flows by Challis, Idaho. The Challis area is a fluvial valley located between semi-arid mountain ranges. The Salmon River enters the valley as a single channel and spreads out across the valley floor in several channels and then leaves the valley as a single channel. As in the upper Salmon River area, livestock grazing and hay production are the major agricultural activities in this area.

Along the Salmon River, at several locations, rock weirs are built into the stream to divert water to irrigation canals. In the Challis area, several of these rock weirs are close together. The irrigation canals are numbered as they occur upstream. Most of the canals have had screens installed acroaa them to prevent fish from traveling down the canals and into the fields. At the screens, bypass pipes are installed to carry the fish back to the Salmon River mainstream.

Two irrigation canal bypass pipes in the Challis area were selected for installation of remote PIT tag monitors. The first monitor is located at the S-27 screen. It is on the south side of the river. The screen is located in the canal approximately 1 km downstream from its diversion weir. The diversion weir is approximately 100 m downstream of our second monitor site. The second monitor site is located at the S-29 screen. It is on the north side of the river. The screen is located approximately 1.4 km downstream from its diversion weir.

METHODS

Physical Habitat Surveys

Physical habitat surveys were conducted using the Idaho ocular method (Petrosky and Holubetz 1987). This method uses established study sites that are marked for repeated measurements. Within each study site, transects are established at 10 m intervals. Stream width is measured at each transect. Depth, velocity, substrate composition, embeddedness, and habitat type are measured or determined at the one-quarter, one-half, and three-quarter points of each stream transect. Velocity was measured with a Price AA portable flowmeter. Proportions of sand (O-O.5 cm diameter), gravel (>O.5-7.4 cm), rubble (>7.5-3O.4 cm), boulder (>3O.4 cm), and bedrock that comprise the substrate are estimated visually. Embeddednesa (the proportion of surface area of gravel, rubble, and boulder surrounded by sand) is estimated in 5% intervals from 0% to 100%. We uae characteristics described by Shepard (1983) to determine habitat types. Stream gradient was measured with a surveyor's transit and stadia rod. Gradient is calculated as the elevation difference between a section's upper and lower boundaries divided by the section's length. Stream channel type was classified according to Rosgen (1985). For future measurements and reference, all sections were flagged and photographed.

Adult Escapement, Redd Counts and Egg Deposition

Actual escapements for adult chinook salmon and steelhead trout in the upper Salmon River were obtained from Sawtooth Fish Hatchery records (Alsager 1992, Coonta 1992). The entire escapement above the hatchery weir consisted of fish that were collected in the hatchery trap and then released upstream to spawn naturally.

Except for a small number of early steelhead trout which may have passed before trap placement or when the trap had to be closed for high water flow, actual escapements of adult steelhead trout into Crooked River were obtained from trap records (Kiefer and Lockhart 1993) and from known Dworshak National Fish Hatchery (DNFH) releases. Adult chinook salmon escapement into Crooked River was obtained from Crooked River adult collection facility records (George et al. 1992).

Counts of steelhead trout redds were conducted by regional fisheries personnel in the upper Salmon River. The count for the upper Salmon River was conducted from Sawtooth Fish Hatchery weir upstream to Frenchman Creek. This was a l-d peak count via helicopter on May 10, 1992. The steelhead trout redd count for Crooked River was conducted on the two meadow sections on May 11, 1992 via helicopter.

Chinook salmon redds in the upper Salmon River were counted via helicopter by regional fisheries personnel on September 1, 1992 (Lukens 1992, intradepartmental report). The count covered the entire probable natural spawning area. An aerial count was not conducted on Crooked River.

In addition to the aerial counts, project personnel conducted a ground redd count of the entire probable steelhead trout spawning areas in upper Salmon River on May 12 and May 13, 1992 and in Crooked River on May 14, 1992. Ground redd counts for chinook salmon spawning areas in upper Salmon River were conducted on August 31 and September 1, 1992 and in Crooked River on September 9, 1992. The ground counts were done by IDFG personnel and data is reported in Hassemer (1993). All salmon carcasses found were measured (fork length and MEH) and cut open to confirm sex and completeness of spawning. Crooked River adult chinook salmon tissue samples for disease analysis, and scale samples for aging and rearing site determinationwere collected fromtrappingmortalities and carcasses found.

The numbers of female chinook salmon and steelhead trout spawning in the upper Salmon River were estimated as the number of females released above the Sawtooth Fish Hatchery weir multiplied by pre-spawning survival observed at Sawtooth Fish Hatchery (0.9725 for chinook salmon [Coonts 1992]; 0.98 for steelhead trout [Alsager 1992]). The average fecundity for the females released above the weir was assumed to be the same as those taken into the Sawtooth Fish Hatchery. Chinook salmon fecundity was 4,503 eggs per female (Coonts 1992) and steelhead trout fecundity was 4,581 eggs per female (Alsager 1992). Egg deposition for steelhead trout and chinook salmon was estimated as the number of female spawners multiplied by the average fecundity after adjusting fecundity for estimated egg retention.

The number of female chinook salmon successfully spawning in Crooked River was estimated from our ground redd counts with an assumed redd to female spawner ratio of 1:1. Chinook salmon fecundity for Crooked River (3,810 eggs per female) was based on estimates from the Red River trapping facility (Brad George, personal communication). In 1992, six wild/natural female steelheadtrout adults were released upstream into Crooked River to spawn naturally. Nine hatchery female steelhead trout adults were released in Relief Creek and eight hatchery female steelhead trout adults were released in West Fork Crooked River. Steelhead trout fecundity (6,942 eggs per female) was based on estimates for steelhead trout at DNFH (John Streufert, personal communication). Egg deposition for steelhead trout and chinook salmon was estimated as the number of female spawners multiplied by the average fecundity after adjusting fecundity for estimated egg retention.

Adult Outplants

Upper Salmon River

The source of all adult chinook salmon and steelhead trout used for outplants in the upper Salmon River was adults trapped at the Sawtooth Fish Hatchery weir. In March and April 1992, adult steelhead trout were outplanted at five sites in the upper Salmon River from the Highway 75 Blaine County bridge to the Highway 75 Vienna turn-out. A total of 97 females and 198 males were outplanted into these sites. Project personnel walked these sites every third day to observe spawning activity, Redds were counted, mortalities were measured for length, and female mortalities were examined for egg retention.

In August, five pair of adult chinook salmon were outplanted into both Frenchman Creek (Strata 2) and Smiley Creek (Strata 1B). A major factor in the selection of these outplant sites was the absence of natural reproduction as determined by our ground redd counts. Picket weirs prevented the fish from moving above or below the release sites. Spawning activity was monitored on alternate days. Carcasses were measured (fork length) and cut open to confirm sex and determine completeness of spawning.

Crooked River

Adult steelhead trout for outplants into Crooked River came from the Crooked River adult trap and DNFH. An adult outplant site was selected on Relief Creek and a picket weir was placed across the stream approximately 0.3 km upstream from the Crooked River road culvert. Ten male and nine female hatchery origin adults captured at the Crooked River trap were released above the picket weir in the Relief Creek outplant site. Seven male and eight female hatchery origin adults captured at the Crooked River trap were released into West Fork Crooked River about 100 m above the confluence with East Fork Crooked River with no picket weir. These hatchery adults were transported to release sites two at a time in a 120 L cooler filled with water. An outplant site was established on Five Mile Creek by placing a picket weir across the creek about 100 m upstream of the Crooked River road. Ten pair of hatchery adult steelhead trout from DNFH were released into Five Mile Creek about 100 m upstream of the picket weir. Crooked River and the three outplant sites were walked several times to count redds and mortalities. Mid-eye to hypural plate lengths (MEH length) were measured on female mortalities and egg retention was estimated (Kiefer and Lockhart 1993).

Nineteen adult chinook salmon captured at the Crooked River trap (10 males, 7 females, and 2 jacks) were transported to the Red River facility and placed in a holding pond. Due to water temperature problems at Red River all fish were later transported to Clearwater Fish Hatchery and held there. Of these 19 adults there were five male, three female, and one jack mortalities at Clearwater Fish Hatchery.

When the adult chinook salmon from Crooked River became ripe, they were transported to the Relief Creek outplant site and released. On August 25, one pair of fish (one female and one jack) was released into the outplant site. On August 28, four pairs of adults were inadvertently released below the outplant site. Three males were outplanted on September 9, 1992 (one into the Relief Creek outplant site and two below the site). Spawning activity in Relief Creek was monitored on alternate days. Records were kept on observed spawning activity and redds; female mortalities were checked for egg retention.

Parr Abundance

Parr abundance by species and age class was estimated by snorkeling through established sections (Petrosky and Holubetz 1985). Surveys were conducted in 36 sections on Crooked River during July 8-12, 1992, and in 82 sections on the upper Salmon River during July 22-27, 1992. Total abundance of steelhead trout and chinook salmon parr was estimated by a multistage sampling design with visual estimation methods (Hankin 1986, Hankin and Reeves 1988). Streams were divided into long sections (strata), each long section was divided into short sections (study sites), and visual population estimates were used in each short section. The estimates from the short sections were expanded to the long sections by multiplying the average size of the small section area by the number of average small sections in the large sections, and then multiplying by the number of fish observed in the small sections.

PIT Tagging

Chinook salmon and steelhead trout parr were PIT tagged in their summer rearing areas during August 19-25, 1992 in the upper Salmon River and August 5-12, 1992 in Crooked River. Additional juveniles were collected and PIT-tagged during the fall and spring emigration trapping operations (see emigration trapping section).

Depending on site suitability and species available, we collected fish for PIT-tagging with a Smith-Root model 12 electrofisher or with a minnow seine. Seines were primarily used to sample pools for chinook salmon parr and the electrofisher was used to sample riffles for steelhead trout parr. The electrofisher was operated with a 30.5 cm diameter anode ring on a 2.0 m pole, 2.4 m rattail cathode, voltage setting between 200 and 400 V, and pulse rates of 90 cycles/s when fishing primarily for chinook salmon and 30 cycles/s when fishing for steelhead trout. Conductivity in the upper Salmon River drainage ranges from lows of 37 μmhos/cm to highs of 218 μmhos/cm (Emmett 1975). The conductivity in Crooked River ranges from lows of 35 μmhos/cm to highs of 50 μmhos/cm (Mann and Von Lindern 1987). We observed that nylon netting tied completely around the anode ring reduced the incidence of electrical burn marks and fish mortality. This modification did not appear to impair capture effectiveness.

Tagging procedures included anesthetizing fish with MS-222 and injecting PIT tags into the body cavity using a 12-gauge hypodermic needle and modified syringe. The needle was oriented anteriorly to posteriorly and inserted just off the mid-ventral line about one-quarter of the distance between the tip of the pectoral fin and the pelvic girdle. Immediately after the needle entered the body cavity it was rotated to change the angle so the bevel of the needle made contact with the inner surface of the body wall. The tag was then inserted.

After each tag was inserted, a loop style PIT tag detector was used to detect and send the tag codes to a battery powered laptop computer. The National Marine Fisheries Service (NMFS) has found that once a functional tag has been successfully implanted in a fish the tag failure rate has been less than 1% (Prentice et al., 1986). Fork length was measured to the nearest 1.0 mm with a CalComp digitizer scale on all fish that were PIT-tagged and all fish that were too small to tag (<55 mm chinook salmon and <60 mm steelhead trout). On most of the fish tagged, fish weight was measured to the nearest 0.1 g on a Port-O-Gram balance. Perforated 1.0 m x 0.5 m x 0.7 m plastic tote boxes were used to hold fish before tagging, during recovery, and for 24-h delayed mortality tests. Copies and print outs of these tag files were made daily.

To determine 24-h delayed mortality and tag loss, all tagged fish were held for 24-h in the perforated plastic tote boxes in the stream sections fish were tagged in. After the 24-h holding period, all fish were scanned to confirm tag presence and then released. Tags were retrieved from any mortalities.

Emigration Trapping

To monitor fall and spring emigration of juvenile anadromous fish, we used floating scoop traps equipped with a 1.0 m wide inclined traveling screen (manufactured by Midwest Fabrications Inc., Corvallis, Oregon). The upper Salmon River trap was located directly below the permanent weir at Sawtooth Fish Hatchery. Water was funneled to the trap from a 3.1 m wide bay of the weir. The funnel was constructed of a picket weir with 3.8 cm spaces that acted as a louver. To evaluate the spring 1992 emigration, the trap was operated continuously (except for breakdowns) from March 5 to June 4, 1992. To evaluate fall emigration, the trap was operated from August 21 to November 4, 1992.

On Crooked River, the trap was located 0.2 km above the mouth of Crooked River about 20 m below the adult trapping weir. A rock weir installed in 1990 helps direct the fish into the trap. To evaluate the spring emigration, the trap operated from March 11 to June 15, 1992. For the fall 1992 emigration, the trap was operated from September 11 to November 11.

The overall run estimates were obtained from emigration trapping operations by summing the daily run estimates. The daily run estimates are calculated by dividing the daily trap catches by the estimated trap efficiencies. Two methods were used to determine trap efficiencies. In the fall trapping season, tagged fish were divided into four groups and released 400 m upstream of the traps. The number of recaptures from each group was divided by the total number of fish released in that group. The efficiency was assumed to be constant for the fall season because water flow varied little. Since spring water flows varied considerably, four groups of tagged fish were released 400 m above the traps for each significant change in water flow.

We used the length frequency of the steelhead trout caught to estimate age composition of the steelhead trout emigrants.

Survival Rates

Estimates of the egg-to-parr survival (age 0 for chinook salmon and age 1+ for steelhead trout) was calculated by dividing the parr population estimate by the estimated egg deposition that produced the parr.

The estimate of steelhead trout age 1+-to-age 2+ survival was calculated from PIT tag detection rates at the smolt collecting dams. For example, for Brood Year (BY) 1989 steelhead trout, we divided the proportion of age 1+ parr PIT tagged in August 1990 detected at the smolt collecting dams in spring 1992 by the proportion of age 2+ parr PIT tagged in August 1991 detected at the smolt collecting dams in spring 1992.

We used PIT tag detection rates at the smolt collecting dams to estimate survival to smolt stage for both species at two different locations. First, we estimated survival to smolts leaving the study area (at the onset of smolt migration). Second, we estimated survival to smolts arriving at the head of Lower Granite (LGR) pool.

For the estimate of survival of smolts leaving the study area we divided the proportion of PIT tag detections at the lower Snake and Columbia rivers' smolt collecting dams of parr PIT tagged in August or during the fall emigration by the proportion of PIT tag detections at the dam5 of smolts PIT tagged during the spring emigration. To make these estimates, we must assume that the groups being compared suffer the same tagging mortality and that smolts from both groups that survive to the dams are detected at the same rate. The equation for this estimate for the August tagged parr is as follows:

$$S_{Study\ Area} = PTD_A/PTD_S \qquad (1)$$

Where:

PTD, = Proportion of August PIT tagged parr detected at the dams

PTD, = Proportion of spring PIT tagged smolts detected at the dams

$S_{Study\ Area}$ = Proportion of August parr surviving to smolts leaving the study area.

For the fall to spring survival estimate we would just replace the PTD, with PTD_F (Proportion of PIT tagged fall emigrants detected at the dams).

For the second estimate we divided the PIT tag detection rate of summer parr, fall emigrants, or spring emigrants tagged in our study area by the detection rate5 of smolts that Buettner (1992) PIT tagged at their traps at the head of LGR pool. For these estimates, we assume that their tagged fish are detected at the dams at the same rate as our tagged fish and that both group5 suffer the same tagging mortality and migration mortality through LGR pool. The equation for this estimate for the August tagged parr is as follows:

$$S_{LGR\ pool} = PTD_{Study\ Area}/PTD_{LGR\ pool} \qquad (2)$$

Where:

$S_{LGR\ pool}$ = Proportion of the study area PIT tagged parr or smolts surviving to head of LGR pool.

$PTD_{Study\ Area}$ = Proportion of the study area PIT tagged parr or smolts detected at the dams

$PTD_{LGR\ pool}$ = Proportion of LGR pool PIT tagged smolts detected at the dams

Delaved Mortalitv Study

On August 24, 1992, a 200 m section of a side channel to the Salmon River that flows through the Sawtooth Fish Hatchery grounds was screened to prevent fish movement into or out of the section. The stream section was seined and electrofished to collect chinook salmon parr. Some of these chinook salmon were PIT tagged and lower caudal clipped and the remaining portion were only upper caudal clipped. All fish were checked for signs of Bacterial Kidney Disease (BKD) and held for 24-h mortality test. Before these marked chinook salmon parr were returned to the study site, we conducted three separate snorkel counts to estimate the number of unhandled chinook salmon parr present within the site.

On October 21, 1992, the side channel was seined once and then electrofished three times to collect fish. A chi-square goodness of fit test was used to test for differences in mortalities among the marked groups.

Remote Monitor

On April 29, 1992, a PIT tag remote monitor was installed on the S-29 irrigation diversion screen bypass pipe in the Challis, Idaho area. The monitor consists of two parts. One part is a metal housing unit with a 4 ft long 6 in diameter PVC pipe running through it. Surrounding the pipe are detector loops and exciter cards. The other part is a housing unit that contains a PIT tag recorder, a computer to store the data, and a 12 volt battery to provide 24-h of operation. The battery was charged continuously with a variable amp charger. When a PIT tagged fish is detected by the monitor, the tagcode, date, and time are recorded on a computer file.

To test the efficiency of this monitor in detecting PIT tagged fish passing through the bypass pipe, we released 20 PIT-tagged artificial fish (6 in plastic rod) directly into the entrance of the bypass pipe on a weekly basis. To estimate the proportion of PIT tagged emigrants passing through this stretch of the Salmon River that enter the irrigation canal, we released PIT tagged emigrants 9 km upstream of the diversion on a weekly basis.

During the spring, the monitor was operated until smolt emigration appeared to be complete (July 1, 1992). The last detection was on June 26, 1992. For fall emigrations, the monitor was restarted on September 16. The monitor was removed on November 5, 1992 after the irrigation diversion was closed for the winter season. The last detections were recorded on November 4, 1992.

Creel Survev

During the summer 1992, a roving survey and roving angler interview creel census (Guthrie et al. 1991) was conducted on Crooked River. The purpose of the creel census was to determine the impact of angling on steelhead trout parr populations in Crooked River. As part of the census, all fish in the creel were measured for length and anglers were asked to estimate the length and number of all fish released. We used the IDFG Creel Census System program (McArthur 1992) to estimate mid-season and late season steelhead trout harvests, numbers of fish caught and released by terminal gear type, angler effort and angler attributes. The census was conducted from May 23, 1992 through September 25, 1992 when fishing pressure decreased significantly.

The hooking mortality of caught and released steelhead trout parr was estimated by multiplying the estimated number of steelhead trout parr caught and released with individual terminal gear by the estimated percent of hooking morality caused from that gear type. The estimated percent of catch-and-release mortalities by terminal gear type were taken from Taylor and White (1992).

To estimate the steelhead trout age 1+ and age 2+ population sizes prior to the fishing season (pre-season estimates), we summed the estimated harvest through July 12, the estimated number of catch-and-release mortalities through July 12, and the snorkel count estimate of the steelhead trout parr population in the stream July 7-12. The estimates of the total seasonal angling impact to age 1+ and age 2+ steelhead trout parr populations were calculated by summing the number of fish harvested and the number of hooking mortalities and then dividing by the pre-season population estimates.

RESULTS

Upper Salmon River

Spring 1992 Emigration Trapping

In spring 1992, we operated a juvenile outmigrant trap on the upper Salmon River to estimate smolt emigration for chinook salmon and steelhead trout. This trap was operated continuously from March 5 to June 4. We captured 297 chinook salmon smolts with an estimated trapping efficiency of 6.1% (90% C.I.; 1.9%-11.3%), and 85 steelhead trout juveniles with an estimated trapping efficiency of 9.1% (90% C.I.; 1.0%-24.1%). We also captured 141 emigrating O. nerka juveniles, presumably from Alturas Lake (Figure 3). We assumed the O. nerka smolts were captured by our trap with the same trap efficiency as chinook salmon smolts.

We estimated total spring 1992 upper Salmon River emigrations of 5,211 (90% C.I.; 2,628-15,632) chinook salmon smolts, 2,474 (90% C.I.; 1,248-7,421) O. nerka smolts, and 934 (90% C.I.; 353-8,500) steelhead trout juveniles. Age composition of the wild/natural steelhead trout emigrants was 6.5% (61) age 2, and 93.5% (873) age 3 and older smolts. We also captured 39 hatchery steelhead trout smolts from the 1990 fry release (Kiefer and Forster, 1992). We estimated that 429 (90% C.I.; 162-3,900) hatchery steelhead trout smolts from the 1990 fry release emigrated from the upper Salmon River in spring 1992.

Using summer 1991 parr abundance estimates (Kiefer and Lockhart 1993) we estimated that 17.0% of the chinook salmon parr, 2.4% of age 1+ steelhead trout parr, and 67.3% of age 2+ and older steelhead trout parr emigrated in spring 1992 as smolts.

Spring 1992 Challis Remote PIT Tag Monitoring

In Spring 1992, we operated a remote PIT tag monitor (monitor) on the fish bypass pipe at the S29 diversion fish screen to collect information on upper Salmon River chinook salmon and steelhead trout smolt migration and survival. This monitor was operated from April 29 to July 1, 1992. We estimate that this monitor detected 83% (90% C.I.; 77%-88%) of the PIT tagged test fish released directly into the entrance to the S29 bypass pipe. The Challis monitor detected 7.9% (90% C.I.; 4.7%-11.9%) of the PIT tagged chinook salmon and steelhead trout smolts we released into the Salmon River 9 km upstream. We estimated that during the irrigation season in spring 1992 9.5% (90% C.I.; 5.9%-14.6%) of the chinook salmon and steelhead trout smolts emigrating through this stretch of the Salmon River passed through the S29 bypass pipe.

The Challis monitor detected 3.3% (3 of 90) spring chinook salmon smolts we PIT tagged and released from our upper Salmon River emigrant trap after the monitor was put into operation. We estimated that 42% (90% C.I.; 28%-70%) of the spring chinook salmon smolts we PIT tagged and released from our upper Salmon River emigrant trap after the monitor began operation survived to this section of the Salmon River (3.3%/0.079 = 42%). The three spring chinook salmon smolts tagged at our upper Salmon River emigrant trap and detected by the monitor took an average of 6.2 days (range 2.5-9.1) to travel the 106 km between the upper Salmon River release site and the monitor site. The monitor detected a total of 17 PIT-tagged wild/natural spring chinook salmon smolts. Thirteen of these chinook salmon smolts were tagged in August 1991; nine by our project in upper Salmon River, three by the NMFS crew in the East Fork Salmon River, and one by

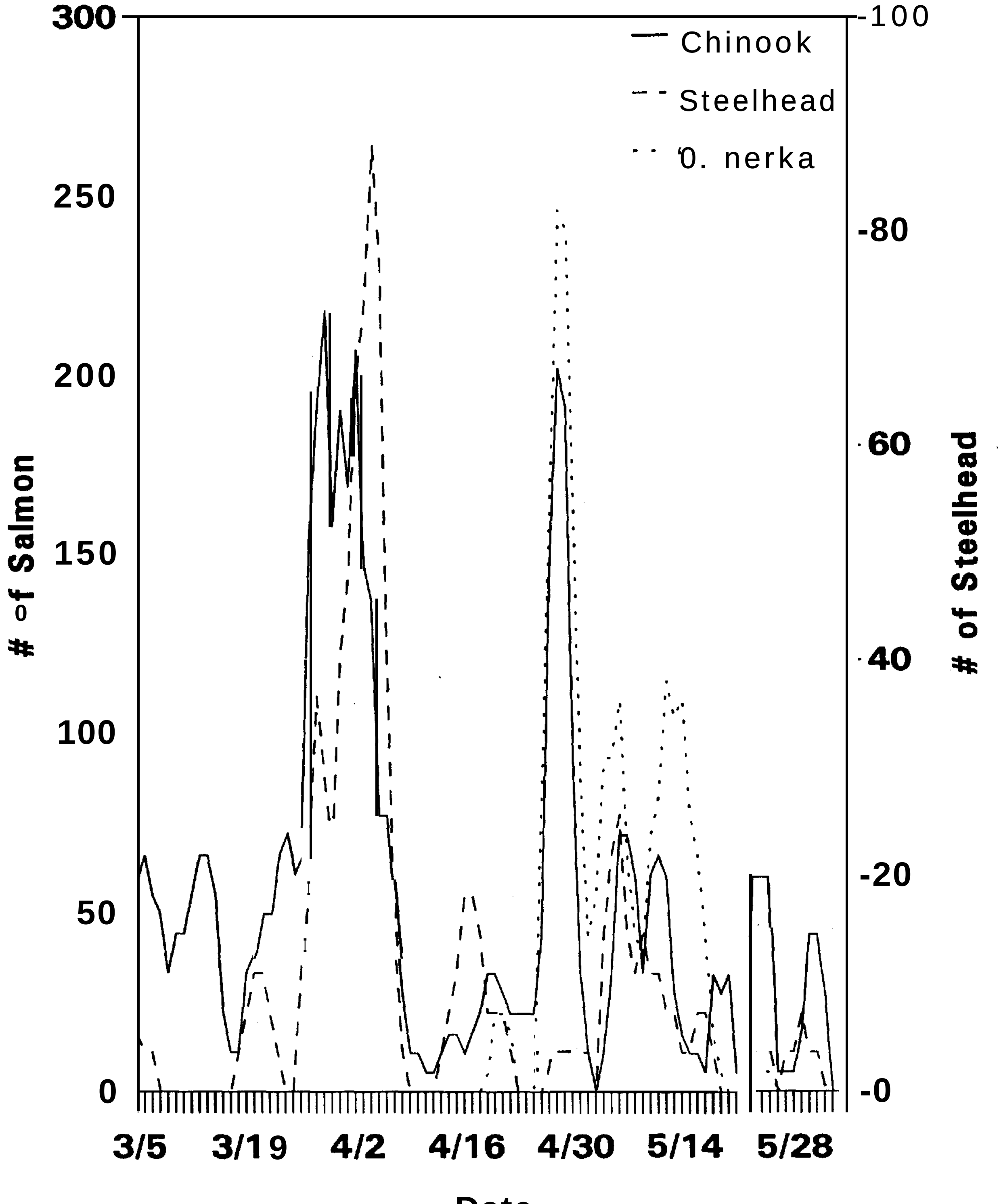

Figure 3. Spring 1992 upper Salmon River chinook salmon, steelhead trout, and O. nerka emigration timing (3 d moving average).

the NMFS crew in Valley Creek. The remaining four were tagged by our project at the upper Salmon River emigrant trap; one in fall 1991, and three in spring 1992.

The Challis monitor detected the following PIT tagged hatchery smolts: two chinook salmon released March 9 at Sawtooth Fish Hatchery; 26 steelhead trout released April 10 at Sawtooth Fish Hatchery; and 9 steelhead trout released April 10 at the East Fork Salmon River trap. Since these smolts were from releases before we began monitoring we could not estimate survival or average travel time.

To determine if the irrigation diversions in the Challis Valley were having a significant impact on the survival of smolts migrating through this stretch of the river we made weekly releases of PIT tagged smolts above and below the valley and compared detection rates at the smolt collecting dams. Because we were only able to consistently collect sufficient numbers of hatchery steelhead smolts, we only used their results in our analysis (Table 1). These data indicate that there may have been a reduction in survival for those smolts released into the Salmon River above the Challis Valley as compared to those released below this valley, even though the distance between release sites was only 36 river km (ANCOVA; df = 1, F-ratio = 4.486, P = 0.072). We observed no significant difference in migration rate between the two release sites (Table 1)(ANCOVA; df = 1, F-ratio = 0.003, P = 0.960).

Estimated Steelhead Trout Egg Deposition

In spring 1992, 1,705 (499 female) adult steelhead trout were captured at the Sawtooth Fish Hatchery Adult Trap (Alsager, 1992). All 44 (18 female) wild/natural adults and 333 (60 female) hatchery adults were released immediately above the weir to spawn naturally. For our carrying capacity research we transported and released 215 (72 female) hatchery adult steelhead trout into the Salmon River between Smiley Creek and Frenchman Creek between March 24 and April 9. On April 13, Sawtooth Fish Hatchery personnel transported 80 (25 female) hatchery adults and released them into the Salmon River at the Blaine County Bridge.

On May 12 and 13, we conducted a ground steelhead trout redd count in the Salmon River from the Sawtooth Fish Hatchery weir to 5 km upstream of Frenchman Creek, and in the lower sections of Pole Creek and Alturas Lake Creek. We observed a total of 46 steelhead trout redds. On May 12, 1992, a steelhead trout redd count from a helicopter was conducted over this same area and 26 redds were observed.

Because of the difficulties in obtaining accurate counts of steelheadtrout redds, we used the past five year average of pre-spawning mortality observed at Sawtooth Fish Hatchery (5%) to estimate that 166 of the 175 females spawned in 1992. We used the brood year average fecundity observed by Alaager (1992) at Sawtooth Fish Hatchery (4,581) to estimate that 760,446 steelheadtrout eggs were deposited in the upper Salmon River in 1992 (Table 2).

We conducted nine steelhead trout redd counts from the ground in the carrying capacity outplant area between April 4 and May 13. The most redds observed at one time in this area was 22 on May 13. However, on several occasions high water made some previous redds unrecognizable and we believe more females successfully spawned.

Table 1. PIT tag detection rates at all Snake and Columbia rivers' smolt collecting dams and migration rates to Lower Granite Dam for PIT-tagged hatchery steelhead trout released into the Salmon River upstream and downstream of the Challis Valley in 1992.

	Released upstream		Released downstream	
Release date	Percentage detected	Migration rate km/day[a]	Percentage detected	Migration rate km/day[b]
04/28/92	53.9	39.0	—[c]	
05/06/92	20.0	32.6	28.6	31.0
05/13/92	14.6	23.7		
05/20/92	8.2	23.9	17.6	24.1
05/27/92	13.4	26.7	8.5	22.4
06/03/92	2.0	24.6	11.5	22.8
06/10/92	5.2	35.7	8.8	42.0

[a] Distance from upstream release site to Lower Granite Dam is 838 km.
[b] Distance from downstream release site to Lower Granite Dam is 802 km.
[c] No downstream releases were made on 4/28 and 5/13.

TABLE1.92

Table 2. Adult steelhead trout escapement, redd counts, and estimate of eggs deposited (in thousands) for the upper Salmon River, BYs 1986-1992.

	Brood Year						
	1986	1987	1988	1989	1990	1991	1992
Total escapement[a]	1,956	979	635	378	528	91	672
Female escapement[a]	322	383	136	157	219	15	175
Helicopter redd counts; mainstream[b]					56	15	29
Ground redd counts; tributaries[b]					4	2	0'
Eggs per female[a]	4,468	4,854	5,069	5,637	4,734	4,019	4,581
Estimated eggs deposited	1,438.7	1,859.0	689.3	885.0	1,036.7	60.3	760.4

[a] Total escapement, female escapement, and eggs per female data are from Sawtooth Fish Hatchery brood year reports.
[b] Redd count data are from Idaho Department of Fish and Game redd count reports.

TABLE2.92

PIT Tag Detections

The combined PIT tag detection rates at the Lower Snake and Columbia rivers' smolt collecting dams for smolts captured and PIT tagged at the upper Salmon River emigrant trap in spring 1992 were 19.2% (56 of 291) for chinook salmon, 10.8% (4 of 37) for O. nerka, and 21.5% (17 of 79) for age 3 and older steelhead trout. For O. nerka smolts PIT tagged and released in Redfish Lake Creek in spring 1992, 24.1% were detected (19 of 79). Eleven (9.5%) of the 116 O. nerka smolts we PIT tagged and released from upper Salmon River and Redfish Lake Creek were detected at LGR Dam, and 10 8.6% were detected at Little Goose Dam.

For the fall 1991 upper Salmon River emigrants, the detection rates were 7.1% (57 of 804) for chinook salmon and 7.6% (6 of 79) for age 2+ and older steelhead trout. Detection data for the August 1991 PIT tagged parr were summed by strata (Table 3). The combined detection rate for upper Salmon River August 1991 PIT tagged parr was 3.5% (69 of 1,996) chinook salmon and 2.2% (6 of 267) age 2+ and older steelhead trout.

To determine if fish size had an effect on survival, we compared PIT tag detection rate and fish size for spring emigrants (Table 4). In spring 1992, no upper Salmon River chinook salmon smolt length group had a significantly different detection rate ($X^2 = 0.91$; $0.75 < P < 0.90$). None of the steelhead trout juveniles smaller than 130 mm were detected at the smolt collecting dams; we assume that most of these smaller steelhead will rear another year or more before smolting.

Detections of PIT tagged smolts in 1992 at the lower Snake and Columbia rivers' smolt collecting dams provides information on O. nerka, chinook salmon, and steelhead trout smolt migration characteristics. A negative correlation was found between upper Salmon River chinook salmon and steelhead trout travel time to LGR Dam and smolt emigration date (Figure 4). Mean smolt travel times to LGR Dam and 90% confidence intervals were estimated to be 37.2 ± 5.8 d for chinook salmon (n = 29), 26.8 ± 4.7 d for steelhead trout (n = 13), and 21.2 ± 10.9 d for O. nerka (n = 11).

Parr Abundance

During the second half of July 1992, we conducted snorkel counts in established study sites of the upper Salmon River to estimate densities and total abundance of chinook salmon and steelhead trout parr. Estimated total parr abundances and 90% confidence intervals were: 45,054 (14,556-75,552) age 0 chinook salmon, 782 (39-1,758) age 1+ steelhead trout, and 458 (188-728) age 2+ and older steelhead trout (Appendix A). Estimated densities and total abundance of age 0 chinook salmon parr were within the range of what we have observed since we began our intensive evaluation in 1987 (Table 5 and Appendix A). Estimated densities and abundance of both age 1+, and 2+ and older steelhead trout parr were the lowest observed since we began our intensive evaluation in 1987 (tables 6 and 7, and Appendix A).

PIT Tagging

During The second half of August, we collected and PIT tagged representative groups of chinook salmon and steelhead trout parr in the upper Salmon River. We PIT tagged 2,294 age 0 chinook salmon parr, and 532 steelhead trout parr. Collecting, tagging, and 24-h delayed mortalities for August PIT tagging totaled 3.9% for chinook salmon parr, and 0.6% for steelhead trout parr.

Table 3. 1992 Detections at the lower Snake and Columbia rivers' smolt collecting dams of August 1991 PIT tagged parr from upper Salmon River.

	Chinook salmon			Steelhead trout age 2+		
Stratum	Number tagged	Number detected	Percent detected	Number tagged	Number detected	Percent detected
SR-3	523	17	3.25	13	1	7.69
SR-4	295	12	4.10	19	1	5.26
SR-9	3	0	0	37	0	0
SR-10	0			37	0	0
HC-1	183	12	6.56	17	0	0
FC-1	13	1	7.69	1	0	0
FC-2	560	15	2.68	0		–
SR-HSC	794	34	4.28	38	0	0
ALC-1	155	5	3.20	2	0	0
PC-1	6	0	0	36	1	2.78
4JC-1	16	2	12.50	92	3	3.26
Totals	2,548	98	3.8	292	6	2.1

[a] Fish collected and PIT tagged for the delayed mortality study (Stratum SR-HSC) were not used to estimate detection rates of the populations.

TABLE3.92

Table 4. Fork length and PIT tag detection rates at lower Snake and Columbia rivers' smolt collecting facilities for chinook salmon and steelhead trout tagged in upper Salmon River, spring 1992.

	Chinook salmon		
Length (mm)	Number tagged	Number detected	Percent detected
< 80	13	1	7.69
80 - 89	55	13	23.64
90 - 99	123	24	19.51
> 99	100	18	18.0
Total	291	56	19.2

	Steelhead trout		
Length (mm)	Number tagged	Number detected	Percent detected
< 90	0	0	
90 - 129	6	0	0
> 129	79	17	21.5
Total	85	17	20.0

TABLE4.92

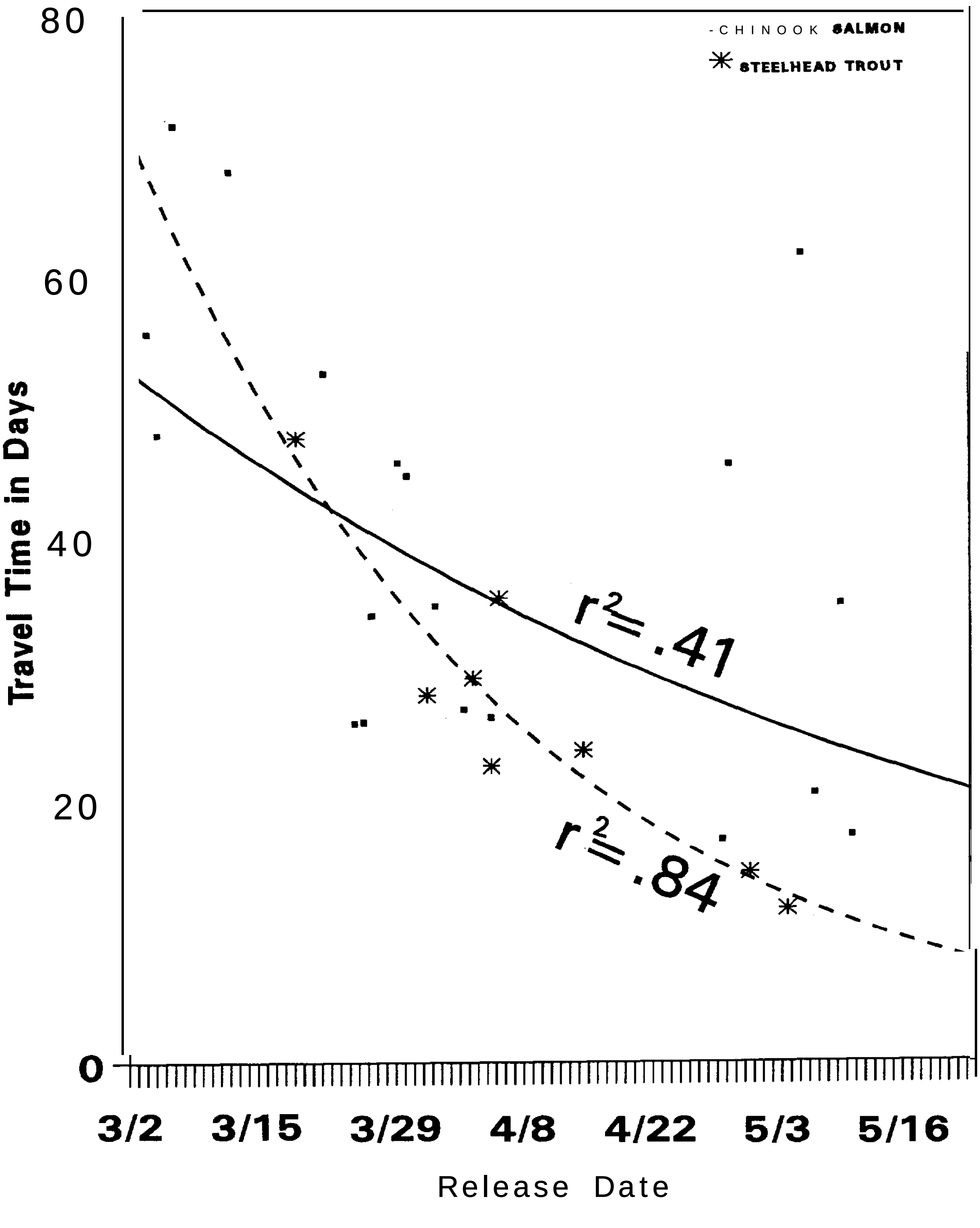

Figure 4. **Spring 1992 chinook salmon and steelhead trout smolt travel time from upper Salmon River trap to Lower Granite Dam.**

Table 5. Density (number/100 m^2) of age 0 chinook salmon in the upper Salmon River during July, 1987 to 1992.

Stratum	1987	1988	1989	1990	1991	1992
Salmon River						
	7.0	13.8	9.7	0.4	2.5	3.5
5, 6	0.3	4.1	3.6	0.1	0.1	0.4
8	20.3	13.3	32.9	3.2	0.1	0.1
9	10.3	3.9	0.6	0	0	0.1
	7.4	1.4	2.6	7.1	0	0
10	0.1	0	32.0	9.8	0	0
Salmon River side channels						
3, 4		16.0	24.6	1.0	5.2	19.1
5, 6		17.9	0.6	1.2	0	0
7		16.1	85.7	4.7	0	1.4
8, 9, 10		6.8	1.7	0	0	0.4
Pole Creek						
1	25.7	2.0	0.9	0	0	0
2	2.9	4.3	11.2	0.3	0.1	0
3	0	0.1	55.8	12.6	5.0	0
4	0	0	0.3	0	0	0
5			0	0	0	0
Alturas Lake Creek						
1[a]	18.3	8.6	20.3	1.9	0.3	CO.1
2[a]						0.9
3[a]						6.4
4[a]	0.6	0.9	2.5	0.4	0	0.2
5[a]	0.1	0	7.7	0.1	0	0
Smiley Creek						
1	35.2	6.9	14.1	0.3	0	0
2	1.1	13.5	23.4	0	0.3	0
3						0
Beaver Creek						
1		2.1	0.4	0	0	0
2		0.4	20.8	0.1	0	0
Frenchman Creek						
1	0	0.6	4.0	0.4	0.3	0
2	0	41.4	109.5	10.2	87.9	79.4
Huckleberry Creek						
1					0.2	2.3
2					0.2	
Gold Creek						
1					30.2	0
4th of July Creek						
1					0	4.0
2					0	
Pettit Lake Creek						
1					0	4.9
Champion Creek						
2					0	0

[a] In 1992, Alturas Lake Creek stratum 1 was split into three strata (1, 2, and 3). Strata 2 was renamed strata 4 and strata 3 was renamed strata 5.

TABLES.92

Table 6. Density (number/100 m^2) of age 1+ steelhead trout parr in the upper Salmon River during July, 1987 to 1992.

Stratum	1987	1988	1989	1990	1991	1992
Salmon River						
3, 4	0.1	0.2	co.1	<0.1	0.1	0.1
5, 6	CO.1	0.1	0	0	co.1	0
7	0.7	0.4	0.2	0.3	0.5	0
8	0.4	0.4	0	0	0	0
9	8.5	2.8	2.6	4.5	0.1	0
10	7.3	3.5	8.4	4.5	0.1	0
Salmon River side channels						
3. 4		0.6	0.2	0.2	0.1	co.1
5; 6		0	0	0	0	0
7		0	0	0	0	0
8, 9, 10		0.3	0	0	0.2	0
Pole Creek						
1	3.0	2.1	0.1	0.2	0.2	0.4
2	5.1	0	0.5	0.3	1.0	0.3
3	0	0	0.3	0.2	0.2	0
4	1.3	4.8	0.8	0	0	0
5	0	0	0	0	0	0
Alturas Lake Creek						
1[a]	0.8	0.6	0.1	<0.1	CO.1	0
2[a]						0
3[a]						0.1
4[a]	0.9	0.4	0	CO.1	0	0
5[a]	0	0.1	0.1	0.1	0	0
Smiley Creek						
1	0.2	0	0.5	0.5	0.1	0
2	0	0.2	0.1	0	0	0
Beaver Creek						
1		0.5	0.1	0.6	0.3	0
2		0.2	0	2.0	0	0
Frenchman Creek						
1	1.8	0	1.5	2.6	0	0
2	0	0.1	0	0	0	0
Huckleberry Creek						
1					0	0
2					0.5	
Gold Creek						
1					0	0
4th of July Creek						
1					0.7	0.1
2					0.4	
Yellowbelly Creek						
1					0.1	0
Petit Lake Creek						
1					0.4	0
Champion Creek						
1					0	0

[a] In 1992, Alturas Lake Creek stratum 1 was divided into three strata (1,2,and 3). Strata 2 was renamed strata 4 and strata 3 was renamed strata 5.

TABLE6.92

Table 7. Density (number/100 m^2) of age 2+ steelhead trout parr in the upper Salmon River during July, 1987 to 1992.

Stratum	1987	1988	1989	1990	1991	1992
Salmon River						
3, 4	co.1	<0.1	0.1	<0.1	co.1	co.1
5, 6	<0.1	co.1	0	0	0	0
7	0	0.1	0.2	0.1	0.3	0
8	0.2	0.1	0.7	0	0	0
9	2.1	0.8	0.9	0.4	0.1	0.6
10	2.4	2.9	4.4	0.5	0.2	0.2
Salmon River side channels						
3, 4		0	0.2	0	0.1	0
5, 6		0	0	0	0	0
7		0	0.4	1.2	0.2	0
8, 9, 10		0	0	0	0.1	0
Pole Creek						
1	1.2	0.6	0.1	0	0	0
2	1.6	0	0.3	0	0.1	0
3	0.1	0	1.2	0.1	0	0
4	1.3	0.5	0.9	0.2	0	0.4
5	0.1	0.7	0	0	0	0
Alturas Lake Creek						
1[a]	<0.1	<0.1	0.1	<0.1	0	0
2[a]						0.1
3[a]						<0.1
4[a]	0.5	0.3	0.1	0	0	0
5[a]	0	0.1	0.1	0.1	0	0
Smiley Creek						
1	0.6	0	0.6	0.3	0	0
2	<0.1	<0.1	<0.1	0.1	0	0
Beaver Creek						
1		0	0.1	0.4	0	0
2		co.1	0	0.3	0	0
Frenchman Creek						
1	2.2	0.61	2.3	1.0	0	0
2	0	0.11	0.1	0	0	0
Yellowbelly/ Pettit Lake Creek						<0.1
Huckleberry Creek						0
Gold Creek						0
4th of July Creek						0.7
Champion Creek						0

[a] In 1992, Alturas Lake Creek stratum 1 was divided into three strata (1,2,and 3). Strata 2 was renamed strata 4 and strata 3 was renamed strata 5.

TABLE7.92

The number of age 0 chinook salmon parr PIT tagged (2,294) was close to our goal of 2,500. However, 432 of the chinook salmon parr we PIT tagged were collected from the side channel at Sawtooth Fish Hatchery, which is outside our study area. These fish were tagged as part of our delayed mortality study and will not be used to estimate study area parr-to-smolt survival. The rest of the chinook salmon parr PIT tagged are divided into the following four different evaluation groups: Salmon River stratum 3 (556 tagged), Forth of July Creek (214 tagged), Alturas Lake Creek Drainage (550 tagged), and Frenchman Creek (541 tagged).

Due to the very low population levels, the number of steelhead trout juveniles PIT tagged (532) was less than our goal of 1,500. The percentage and number of the different steelhead trout parr age groups PIT tagged were; 91% (483) age 0, 0% age 1+, and 9% (49) age 2+ and older. Many of the steelhead trout age 0 parr we PIT tagged (393) were from stratum SR-9 (Salmon River between Smiley and Frenchman creeks). These age 0 steelhead'trout parr were produced from the 395 (97 females) hatchery steelhead trout adults transported to this area in order to determine if their egg-to-parr survival will be higher than for hatchery adults released just upstream of the Sawtooth Fish Hatchery weir. A majority (36 out of 49) of the age 2+ and older steelhead trout part we PIT tagged had fork lengths greater than 164 mm and were probably age 3+ and older.

Delayed Mortality Study

On August 24, 1992, we collected 807 chinook salmon parr with beach seines from a side channel to the Salmon River that runs through the Sawtooth Fish Hatchery grounds. We PIT tagged and lower caudal nipped 432 of these parr and upper caudal nipped the remaining 375. The PIT tagged chinook salmon parr were examined for visual signs indicating BKD infection (bloated bodies and/or popeye), and 15 (3%) showed BED symptoms. Before the marked fish were returned to the study site we conducted three separate snorkel counts. Each snorkel count was conducted with different observers. We counted 828, 735, and 734 total fish (C.I. = 766 ± 91, a = 0.10). From these snorkel counts we estimated the number and fork lengths of the following piscivorous fish: 12 steelhead/rainbow trout (120-160 mm), 14 residualized hatchery steelhead trout smolts (130-180 mm), and 7 brook trout (120-200 mm). To increase the number of piscivorous fish in the study site, we added nine brook trout (140-200 mm fork length) on September 3, 1992. We increased the number of piscivorous fish to increase our probability of detecting a significant difference in predation rate on PIT tagged chinook salmon parr.

On October 21, 1992, we collected 986 chinook salmon parr from the study site, 650 with beach seines and 336 with a backpack electrofisher. Of these 986 chinook salmon parr, 244 had lower caudal nips and PIT tags, 224 had upper caudal nips, and 518 were unmarked. All of the 244 chinook salmon parr with lower caudal nips had working PIT tags in them. Although the clipped fins had regenerated, color variations in the regenerated portion and the clip scar made the clipped fin easily discernable from unclipped fins. We did not find any marked chinook salmon parr outside of the study site, indicating that emigration did not occur or was not significant. However, immigration into the study site did occur based on results of our second sampling. On examining the fish collected inside the study area, we found one fin-clipped hatchery chinook salmon parr and one PIT-tagged natural chinook salmon part that had both been released into the Salmon River upstream of the study area after we had installed the blocking weirs. Obviously, if two marked chinook salmon parr were able to get through the upstream blocking weir into the study site, so were an unknown number of unmarked chinook salmon parr.

On October 20, 1992, we collected a residualized hatchery steelhead trout smolt that had a PIT tag inside it that was originally inserted into a chinook salmon parr in August. We believe the most likely scenario is that the PIT tagged chinook salmon parr (alive or dead) had recently been eaten by this residualized hatchery steelhead trout smolt.

Our null hypothesis for the chi-square goodness of fit test was that all three groups would be recaptured in October in the same proportion they were observed in August. There was no significant difference in mortality rate (Table 8) among these groups (X^2 = 6.213; 0.25 ≥ P ≥ 0.10).

Fall 1992 Emigration Trapping

During fall 1992, we operated a juvenile outmigrant trap on the upper Salmon River to estimate chinook salmon and steelhead trout pre-emolt emigration. This trap was operated continuously from August 21 to November 4, 1992. We captured 776 chinook salmon pre-smolts with an estimated trapping efficiency of 12.0% (90% C.I.; 8.2%-16.5%), and 86 steelhead trout juveniles with an estimated overall trapping efficiency of only 3.8%. We were unable to calculate a confidence interval for fall 1992 steelhead trout juvenile trap efficiency because of small sample size and temporal distribution of recaptures. We only recaptured three of the 78 steelhead trout juveniles PIT tagged and released upstream of the trap, and all three were recaptured on the same day. We estimated total fall 1992 upper Salmon River emigrations of 6,467 (90% C.I.; 4,703-9,463) chinook salmon pre-smolts and 2,263 steelhead trout juveniles.

Age composition of steelhead trout emigrants based on trap captures was 80% (1,810) age 0, 8% (181) age 1+, and 12% (272) age 2+ and older. The estimated percentages of summer 1992 parr populations that emigrated in the fall were 14.2% for age 0 chinook salmon, 23.3% for age 1+ steelhead trout and 56.8% for age 2+ and older steelhead trout.

In fall 1992, both chinook salmon and steelhead trout parr had similar peaks of emigration, and these peaks corresponded with increases in discharge (Figure 5).

Fall 1992 Challis Remote PIT Tag Monitoring

In fall 1992, we operated a remote PIT tag monitor (monitor) on the fish bypass pipe for the S29 diversion screen on the Salmon River near Challis, Idaho. This monitor was operated from September 16 to November 4, 1992. There were a few periods when the monitor was not operating due to mechanical problems. However, we estimated the monitor was operating during the time that 91.4% of the fish emigration was occurring.

This monitor detected 91.2% (90% C.I.; 79.4-98.3%) of the PIT tagged test fish released directly into the entrance to the S29 bypass pipe, and 15.4% (90% C.I.; 12.7-18.3%) of the PIT tagged chinook salmon pre-smolts released into the Salmon River 9 km upstream. We estimated that 19.1% (90% C.I.; 14.6-24.2%) of the chinook salmon pre-smolts emigrating through this stretch of the Salmon River in fall 1992 during the irrigation season passed through the S29 bypass pipe.

On October 2, 1992, 414,972 hatchery chinook salmon pre-smolts were released at the Sawtooth Fish Hatchery weir, including 4,749 PIT tagged fish in 12 different test groups. The monitor in Challis (106 km downstream) detected 16.5% (90% C.I.; 14.5-18.7%) of these PIT tagged hatchery chinook salmon pre-smolts. We estimated that virtually 100% of the hatchery chinook salmon pre-smolts from this release at Sawtooth Fish Hatchery emigrated downstream of the Challis monitor site to overwinter and had survived to this point. We did not observe an increase in the number of PIT tagged wild/natural chinook salmon pre-smolts

Table 8. 1992 PIT tagged chinook salmon parr delayed mortality study chi-square results.

	Captured in Auaust	Recaptures in October 1986)	
		Expected	Observed
PIT tagged and clipped	432	271	244
No. clipped only	375	235	224
No. not handled	766 ± 91	480	518

TABLE8.92

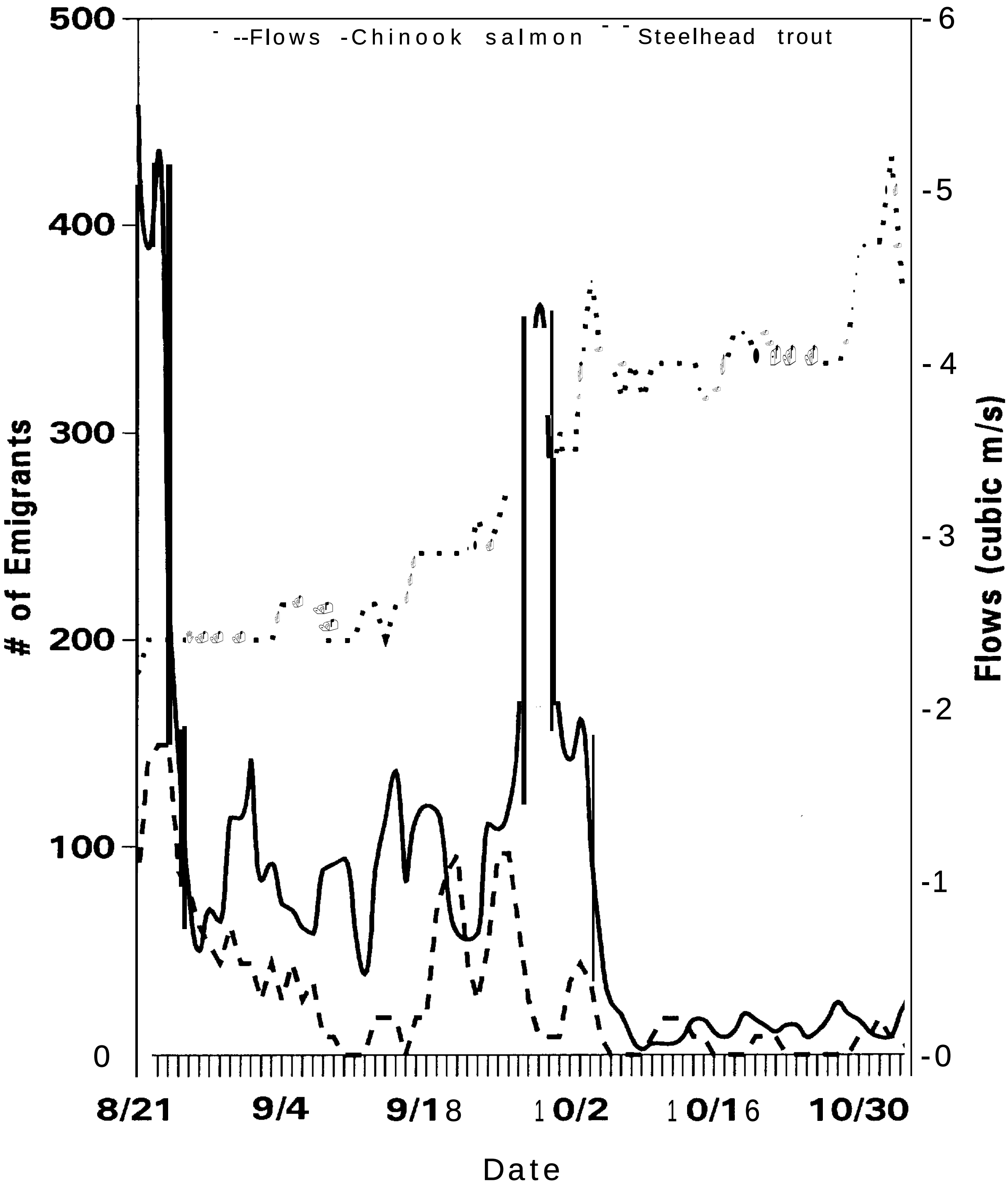

Figure 5. **Fall 1992 upper Salmon River chinook salmon and steelhead trout emigration timing** and **flows (3 d moving average).**

tagged and released at our upper Salmon River emigrant trap being detected by the monitor in Challis. This indicates there was no "pied piper" effect on wild/natural chinook salmon responding to the large number of hatchery fish emigrating.

The Challis monitor also detected PIT tagged hatchery chinook salmon pre-smolts released October 5 into the upper Salmon River for the Idaho Supplementation Studies research project. The Challis monitor detected 9.3% (74 of 800) PIT tagged hatchery chinook salmon pre-smolts released downstream of the S45 (Busterback) diversion, and none of the 1,598 PIT tagged hatchery chinook salmon pre-smolts released upstream of this diversion. We estimated that 60% (90% C.I.; 51-73%) of the hatchery chinook salmon pre-smolts released below the S45 diversion emigrated past the Challis monitor site to overwinter.

The monitor detected the following percentages of wild/natural chinook salmon parr PIT tagged in August upstream of Challis; East Fork Salmon River 1.9% (20 of 1,062), Valley Creek 0.2% (2 of 1,028), and upper Salmon River below the S45 diversion 0.1% (1 of 1,106). In addition, the monitor detected the following percentages of other wild/natural chinook salmon groups; upper Salmon River fall emigrant trap 1.5% (7 of 460), delayed mortality study fish release into the Salmon River 0.5 km upstream of the Sawtooth Fish Hatchery weir 1.2% (5 of 433), and delayed mortality study fish released into the Salmon River side channel at Sawtooth Fish Hatchery 0.4% (2 of 542).

We estimated that 9.7% (1.5%/0.154) of the upper Salmon River chinook salmon fall emigrants overwintered downstream of the S29 diversion. Because of the small sample size of upper Salmon River chinook salmon fall emigrants detected at the S29 monitor we were unable to calculate a confidence interval for this estimate.

Estimated Chinook Salmon Egg Deposition

In 1992, 125 (46 females) of the 387 adult chinook salmon captured at the Sawtooth Fish Hatchery adult trap were released above the weir to spawn naturally (Table 9).

During the first 3 d of September, a total of 27 chinook salmon redds were observed via ground counts, and 29 via helicopter counts in the entire probable natural spawning areas (Table 9). We believe that our redd counts were conducted too early in 1992 and represent fewer redds than were actually constructed. During our ground counts, we observed 39 live chinook salmon adults and only two carcasses. We observed several females in areas with no redds. Therefore, we assume spawning was not completed when the counts were made.

Potential egg deposition in upper Salmon River for brood year 1992 chinook salmon adults released above the hatchery weir to spawn naturally was not calculated from the observed number of redds. Because we believe we conducted our chinook salmon redd counts too early in 1992, we used the past five years' average of female pre-spawning mortality observed at Sawtooth Fish Hatchery (5%) to estimate that 44 adult females successfully spawned. The average fecundity in 1992 observed at Sawtooth Fish Hatchery for the same stock of chinook salmon was 4,503 eggs per female (Coonts 1992). We examined carcasses collected from the adult outplant sites and estimated an average egg retention of 100 eggs per female. We estimated potential egg deposition to be 193,732 chinook salmon eggs.

Table 9. Adult chinook salmon escapement, redd counts, and estimate of eggs deposited (in thousands) for Upper Salmon River, BYs 1986 to 1992.

	Brood Year						
	1986	1987	1988	1989	1990	1991	1992
Total escapement'	876	506	552	470"	615	238	145
Female escapement*	248	252	275	73[e]	167'	94	56
Helicopter redd count[b]	105	124	76	52	60	46	29
Ground redd count[b]			261	123	100	67	27
Eggs per female'	5,156	5,399	5,653	5,456	4,501	5,192	4,503
Estimated eggs deposited[d]	1,278.7	1,360.5	1,554.5	671.1	450.1	347.9	193.7'

[a] Total escapement and female escapement are from Sawtooth Fish Hatchery brood year reports.
[b] Redd count data are from Idaho Department of Fish and Game redd count reports.
[c] Number is average eggs/female observed at Sawtooth Fish Hatchery.
[d] Estimates of average egg retention are incorporated in calculating egg deposition.
[e] Portions of the Sawtooth Fish Hatchery weir were pulled due to high water and uncounted fish probably passed the weir.
[f] Chinook escapement above Sawtooth Fish Hatchery was reduced by at least 65 adults due to a rotenone kill.
[g] Because'we believe we conducted our redd counts too early in 1992, we used the 1987-1992 average pre-spawning mortality observed at Sawtooth Fish Hatchery (5%) to estimate that 44 females spawned in 1992.

TABLE9.92

Adult Chinook Salmon Outplants

On August 22, we outplanted five pair adult chinook salmon into the Frenchman Creek outplant site, and on August 10 we outplanted another five females and seven males into the Smiley Creek outplant site (Table 10). When conducting a redd count in the Frenchman Creek outplant site on September 16, a crew member found an egg skein on the bank that was from an adult chinook salmon female that had apparently been harvested illegally.

We observed a total of four and five redds in the Frenchman Creek and Smiley Creek outplant sites, respectively. We estimated an average egg retention of 100 eggs per female from the carcasses we examined in these two outplant sites. We estimated 17,612 chinook salmon eggs were deposited in the Frenchman Creek adult outplant site, and 22,015 in the Smiley Creek outplant site.

Survival Rates

The BY 1991 chinook salmon egg-to-parr survival for the headwaters of the Salmon River outplant was estimated to be 38.2% (Table 11). For BY 1987-1991, the average chinook salmon egg-to-parr survival for the headwaters of the Salmon River averaged 24.0% (90% C.I.; 12.3-38.2%). For the entire upper Salmon River we estimated BY 1991 chinook salmon egg-to-parr survival to be 12.9% (Table 12). For BY 1987-1991, the average chinook salmon egg-to-parr survival for the entire upper Salmon River study area averaged 6.0% (90% C.I.; 3.9-8.5%). Estimated BY 1991 steelhead trout egg-to-age 1+ parr survival rate for the entire upper Salmon River was only 1.3%

We estimated that parr-to-smolt (at the onset of smoltmigration) overwinter survival in the upper Salmon River was 18.2% for age 0 chinook salmon and 10.2% for age 2+ and older steelhead trout. For migration years 1989-1992, the average chinook salmon overwinter survival averaged 18.7% (90% C.I. of 17.2-20.1%).

The estimated survival, to the head of LGR pool, for parr PIT tagged in August 1991 was 5.7% for age 0 chinook salmon and 3.0% for age 2+ and older steelhead trout. For pre-smolts PIT tagged during the fall 1991 emigration, the estimated survival to the head of LGR pool was 11.5% for age 0 chinook salmon, and 10.4% for age 2+ and older steelhead trout. For smolts PIT tagged during the spring 1992 smolt emigration, the estimated survival to the head of LGR pool was 31.1% for chinook salmon and 29.5% for steelhead trout. By assuming that PIT tagged O. nerka smolts will be detected at the smolt collecting dams at a similar rate to PIT tagged chinook salmon smolts, we estimated that O. nerka smolts captured by our trap in the upper Salmon River (presumably from Alturas Lake) had a survival rate of 17.5%, while those captured in Redfish Lake Creek had a survival rate of 39.1%.

Physical Habitat

During 1992, in the upper Salmon River study area, a physical habitat survey was conducted by USFS personnel on 31 study sites. In the Crooked River, study area, physical habitat surveys were conducted by IDFG project personnel on 17 study sites. Project data have been entered into the IDFG physical habitat database. The management of this database is handled by the Idaho Habitat Evaluation for Off-Site Mitigation Record project'and is reported in Rich et al. 1993.

Table 10. Upper Salmon River chinook salmon supplementation, summary by BYs 1986 to 1992.

	Brood Year						
	1986	1987	1988	1989	1990	1991	1992
Adult females	0	6	30	9	40	13	10
Eyed eggs	0	28,000	56,530	0	0	0	0
Fry	0	48,000	326,000	0	0	0	0
Fall parr	0	43,000	0	2,000	0		191,500

TABLE10.92

Table 11. Estimated chinook salmon egg-to-parr survival rates (%) from the headwaters of the upper Salmon River adult outplants and natural spawners, BYs 1987 to 1991.

Adult Origin	Population Parameter	Brood Years 1987	1988	1989	1990	1991
Adult Outplants	Females outplanted	6	30	9	40	13
	Redds Observed	5	30	9	13[a]	10
Natural Spawners	Redds Observed	0	6	4	0	0
Combined Numbers	Egg Deposition	26,995	203,508	72,800	58,513	51,917
	Parr Production	8,625	35,938	5,054	18,214	19,838
	Egg-to-Parr Survival (%)	32.0	17.7	6.9	31.1	38.2

[a] In 1990, we were unable to estimate total egg deposition in two of our outplant streams and data from these two streams were not included in estimating egg-to-parr survival.

TABLE11.92

Table 12. Egg-to-Parr survival rates for natural chinook salmon in the entire upper Salmon River, BYs 1984 to 1991.

	Brood Year						
	1984	1986	1987	1988	1989	1990	1991
Estimated egg deposition in thousands[a]	1,095.1	1,287.7	1,360.5	1,554.5	671.1	450.1	347.9
Parr production in thousands	73.5	65.7	70.3	88.0	14.2	30.6	45.0
Egg-to-Parr survival	6.7%	5.1%	5.2%	5.7%	2.1%	6.8%	12.9%

[a] From Table 9.

TABLE12.92

RESULTS

Crooked River

Spring 1992 Emigration Trapping

In spring 1992, we operated a juvenile outmigrant trap on Crooked River to estimate smolt emigration for chinook salmon and steelhead trout. This trap was operated continuously from March 11 to June 15, 1992. We captured 1,075 chinook salmon smolts with an estimated trapping efficiency of 45.9% (90% C.I.; 35.3-56.6%). Steelhead trout juveniles captured included: 416 age 3 and older steelhead trout smolts captured with estimated trapping efficiency of 13.3% (90% C.I.; 10.0-17.1%); 684 age 2 steelhead trout captured with estimated trapping efficiency of 21.0% (90% C.I.; 12.8-30.6%); and 1,333 age 1 steelhead trout captured with estimated trapping efficiency of 23.1% (90% C.I.; 19.5-26.8%).

We estimated total spring emigrations of 2,342 (90% C.I.; 1,899-3,045) chinook salmon smolts, and 3,128 (90% C.I.; 2,433-4,160) age 3 and older steelhead trout smolts. We also estimated total emigrations for younger juvenile steelhead trout of 3,257 (90% C.I.; 2,235-5,344) age 2, and 5,771 (90% C.I.; 4,974-6,836) age 1. As in past years, peaks in both chinook salmon and steelhead trout emigration from Crooked River corresponded with increases in discharge (Figure 6).

Estimated Steelhead Trout Egg Deposition

In 1992, a total of 53 adult steelhead trout (30 males and 23 females) were captured at the Crooked River Trap. The first fish was trapped on March 27 and the last fish on May 2. Nineteen of the adults captured (13 males and 6 females) were wild/natural fish and were released immediately upstream of the weir. The remaining 34 adults (17 males and 17 females) were transported to two different outplant sites and released. Nine pair of hatchery adult steelhead trout were released upstream of a picket weir in Relief Creek. This weir was located 100 m upstream of where Relief Creekcrosses the Crooked River Road. The other eight pair of hatchery adult steelhead trout were released into the West Fork Crooked River approximately 100 m upstream of its confluence with the East Fork Crooked River. There was no barrier weir placed in the West Fork Crooked River. In addition, we outplanted 10 pair of hatchery adult steelhead trout from DNFH into Fivemile Creek above a barrier weir located approximately 100 m upstream of the Crooked River Road.

Three ground redd counts were conducted in Crooked River and the outplant sites between May 1 and May 14, 1992. We observed a total of 32 redds in the following areas; 19 redds in Crooked River above the weir, 8 redds in Relief Creek, 2 redds in Fivemile Creek, 0 redds in West Fork Crooked River, and 3 redds in Crooked River below the weir. We do not know if the fish that produced the three redds below the Crooked River weir were of wild or hatchery origin. Since the redds observed below the weir are outside of our study area, we did not include them in our estimate of egg deposition. Only two female mortalities were found; both were pre-spawning mortalities in Fivemile Creek from the DNFH adult release.

We believe that all the adults released into the West Fork Crooked River moved downstream to the main Crooked River to spawn. We hypothesize that some of the DNFH adults released into Fivemile Creek escaped past the barrier weir and spawned in the main Crooked River as well. This hypothesis is based on the low number of female steelhead trout accounted for in Five Mile Creek and that we

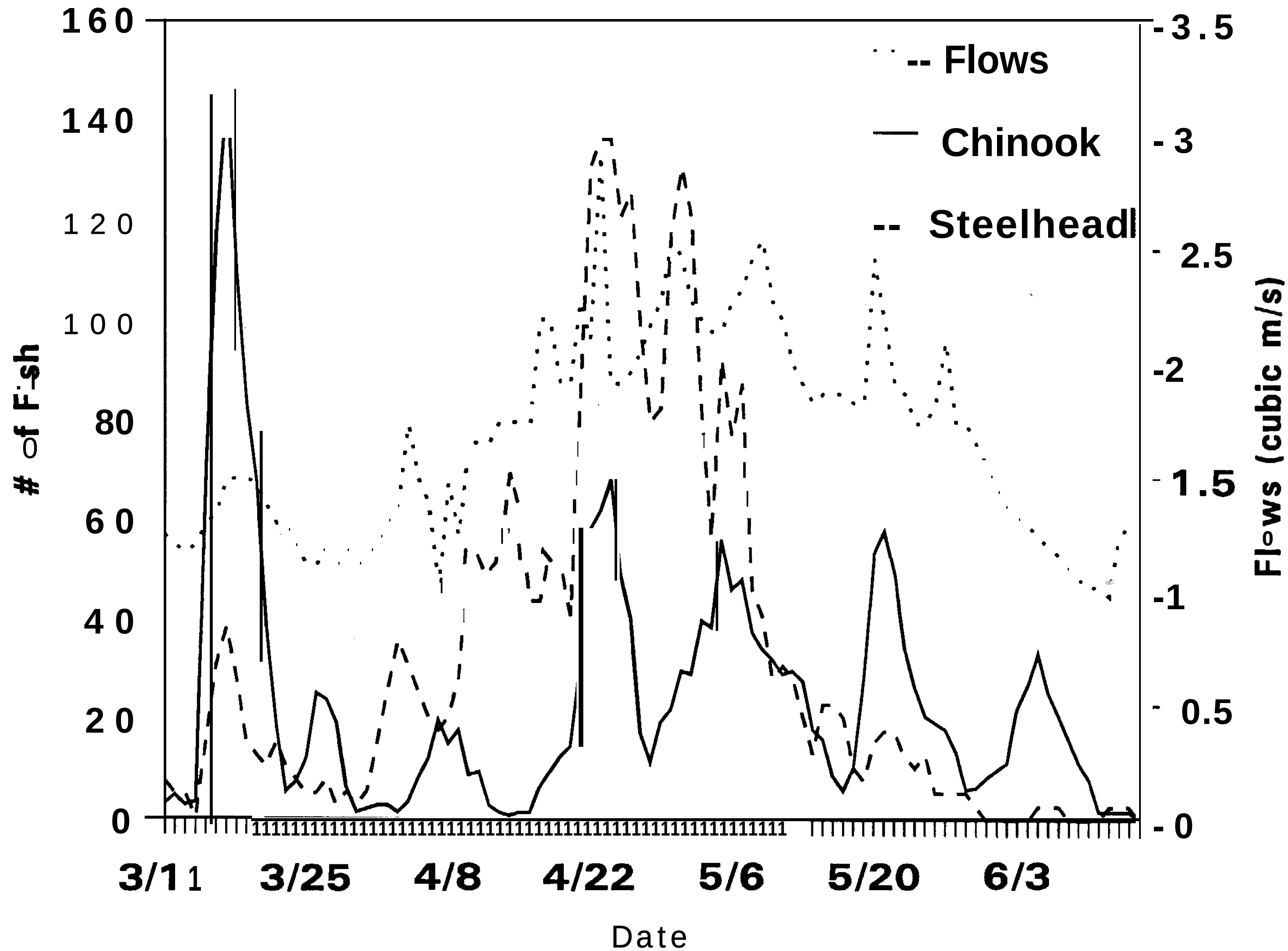

Figure 6. Spring 1992 Crooked River chinook salmon and steelhead trout emigration timing and flows (3 d moving average).

observed more redds than the number of females released in Crooked River, and many of the redds were located near the mouth of Fivemile Creek.

We assumed a female to redd ratio of 1:1 to estimate that 29 of 33 steelhead trout females released above the weir spawned. We used the average fecundity observed at DNFH (6,942) to estimate a total egg deposition of 201,318.

PIT Tag Detections

Mean smolt travel times and 90% CI to LGR Dam were estimated to be 46.6 ± 3.3 d for 139 chinook salmon and 16.7 ± 1.8 d for 182 steelhead trout.

The combined PIT tag <u>detection rates</u> at all the lower Snake and Columbia rivers ' smolt collecting dams for smolts captured, PIT tagged, and released at the Crooked River emigrant trap in spring 1992 were 18.8% (202 of 1,072) for chinook salmon, and 50.2% (204 of 406) for age 3 and older steelhead trout. For the fall 1991 Crooked River emigrants, the detection rates were 8.7% (79 of 908) for chinook salmon and 27.5% (87 of 316) for age 2+ and older steelhead trout. Detection data for the August 1991 PIT tagged parr were summed by strata (Table 13). The combined detection rates for parr PIT tagged in August 1991 were 26.1% (6 of 23) for chinook salmon and 24.2% (99 of 409) for age 2+ and older steelhead trout. We do not believe that the Crooked River chinook salmon parr we PIT tagged in August 1991 were representative of the entire population. These 23 chinook salmon parr were the few large enough to be PIT tagged out of over 300 collected in 1991. In addition, a sample size of only six chinook salmon smolts detected is too small for a valid estimate.

To determine if fish size had an affect on survival, we compared PIT tag detection rate and fish size for spring emigrants (Table 14). In spring 1992, no chinook salmon smolt length group had a significantly different detection rate (X^2 = 1.09; 0.75 < P < 0.90) as compared to other length groups. Steelhead trout juveniles less than 130 mm in fork length were detected at a much lower rate than those ≥130 mm fork length. However, most steelhead trout juveniles less than 130 mm fork length will rear another year or more before smolting.

Detections of PIT tagged smolts in 1992 at lower Snake and Columbia rivers' smolt collecting dams provides information on chinook salmon and steelhead trout smolt migration characteristics. A negative correlation (r^2 = 0.66) was found between travel time to LGR Dam and chinook salmon smolt emigration date (Figure 7). Travel time for steelhead trout smolts from Crooked River to LGR Dam had a negative correlation with emigration date of only (r^2 = 0.37). This is the lowest negative correlation for travel time and emigration date we have observed for either species from either study area (Kiefer and Lockhart 1993).

Parr Abundance

During the first half of July 1992, we conducted snorkel counts in established study sites of Crooked River to estimate densities and abundance of chinook salmon parr and steelhead trout parr. Estimated total parr abundances and 90% confidence intervals were: 415 ± 213 age 0 chinook salmon, 20,528 ± 3,221 age 1+ steelhead trout, and 4,021 ± 565 age 2+ and older steelhead trout (Appendix B).

Chinook salmon parr densities were the lowest we have estimated since we began our intensive evaluation in 1986 (Table 15). The majority of the chinook salmon parr observed were in Relief Creek (where we outplanted adults in 1991) and in Stratum 2 of Crooked River near the mouth of Relief Creek (Table 15).

Table 13. 1992 Detections at the lower Snake and Columbia rivers' smolt collecting dams of August 1991 PIT tagged parr from Crooked River.

	Chinook salmon			Steelhead trout ace 2+		
Stratum	Number taaoed	Number detected	Percent detected	Number taaaed	Number detected	Percent detected
CR-I	1	0	0	50	20	40.0
CR-II	6	1	16.7	38	14	36.8
CR-III	1	0	0	86	29	33.7
CR-IV	3	2	66.7	34	18	52.9
CANYON	12	3	25.0	76	19	25.0
RC	O	O	-	1	O	O
TOTALS	23	6	26.1	285	100	35.1

TABLE13.92

Table 14. Fork length and PIT tag detection rates for Crooked River, spring 1992.

Length (mm)	Number tagged	Number detected	Percent detected
		Chinook salmon	
<80	406	79	19.46
80 - 89	381	71	18.63
90 - 99	263	49	18.63
>99	22	6	27.30
Total	1,072	205	19.12
		Steelhead trout	
<90	775	1	0.13
90 - 129	668	19	2.84
> 129	406	207	50.98
Total	1849	227	12.28

TABLE14.92

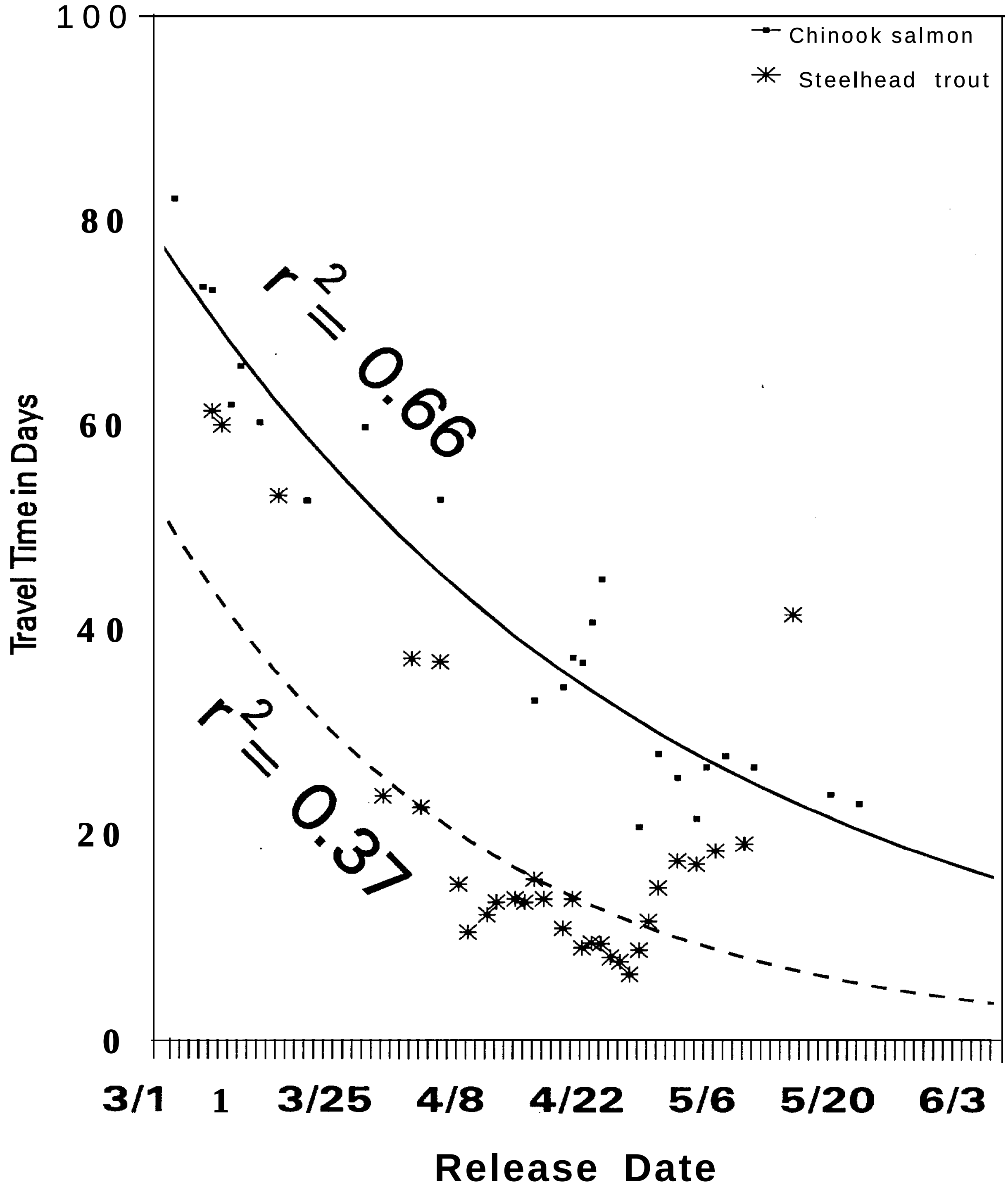

Figure 7. **Spring 1992 chinook salmon and steelhead trout smolt travel time from the Crooked River trap to Lower Granite Dam.**

Table 15. Density (number/100 m^2) of age 0 chinook salmon in Crooked River, August 1906 to 1992.

Stratum	1986	1987	1988	1989	1990	1991	1992
Headwaters			<O.1	0.1	0	–[a]	0
I	14.0	3.0	23.8	28.4	<O.1		0
II	1.1	16.5	19.7	19.7	co.1	–	0.6
Canyon			8.0	10.3	1.0		co.1
III	57.8	22.3	36.6	58.7	5.0		0.1
IV	71.8	15.4	42.2	59.0	4.7		0.1
Relief Creek			0.8	45.5	0		0.9
Ponds A[b]	62.9	3.2	65.4	206.1	0.6		0.3
Ponds B				268.0	8.1		0
5 Mile Creek							0

[a] Snorkel counts were conducted before the chinook age 0 parr probably emerged from the gravel and none were observed.

[b] In 1986-1988, the data for connected ponds was combined and is reported here as Ponds A.

TABLE15.92

We believe our snorkel count estimate of age 0 chinook salmon (415 ± 213) to be significantly less than the true abundance. In August, we collected 369 age 0 chinook salmon in Crooked River for PIT tagging and believe we did not collect close to half of the parr that were present. In fall 1992, using our emigrant trap data, we estimated that 545 (90% C.I.; 286-1,590) chinook salmon pre-smolts outmigrated. Since the July 1992 parr estimate and fall 1992 emigrant estimate were not significantly different, we could conclude that 100% of the parr emigrated out of the system in fall 1992. However, from past years data we estimated that on average approximately 24% of the age 0 chinook salmon summer population will emigrate in the fall from Crooked River (Kiefer and Lockhart 1993). We used our fall emigrant trap data in a Ricker (1975) adjusted Peterson estimate (see fall emigration trapping discussion section) to estimate an age 0 chinook salmon summer parr population of 2,601 (90% C.I.; 1,438-3,764). We believe this population estimate based on PIT tag mark/recapture data to be more accurate.

Steelhead trout age 1+ and 2+ parr densities were among the highest we have observed in Crooked River (Table 16). Densities of age 1+ steelhead trout parr from strata 1 and 2 of Crooked River in 1992 indicate that complex and boulder habitat improvement structures in these strata increased the carrying capacity for summer age 1+ steelhead trout parr and simple sill log structures did not (Figure 8).

Creel Survey

From May 23 to September 25, 1992, angling effort on Crooked River was estimated to be 6,164 ± 1,098 h (C.I. 95%) or 206.5 h/ha. Seventy-four percent of all anglers caught at least one fish, 42% of all anglers harvested at least one fish, and 23% of all anglers harvested a limit of six fish. Fifty-six percent of all anglers released at least one fish, and 35% of all anglers released more than six fish. Bait fishing was the most common method of angling (51%), followed by fly fishing (26%), and lure fishing (23%). The average catch rate was 2.7 fish/h.

Anglers harvested an estimated 4,175 ± 1,582 game fish, and caught and released an estimated 21,118 ± 7,757 game fish. Age 1+ and age 2+ wild/natural steelhead trout parr comprised 11% and 47%, respectively, of the total harvest. Other fish in the harvest included hatchery rainbow trout (25%), cutthroat trout (11%), mountain whitefish (2%), bull trout (2%), residual hatchery steelhead trout smolts (1%), and brook trout (1%). Anglers harvested an estimated 546 ± 360 age 1+ and 1,946 ± 1,033 age 2+ wild/natural steelhead trout parr. The combined catch-and-release of age 1+ and age 2+ wild/natural steelhead trout parr was estimated to be 17,959 ± 7,055. We estimated that 2,577 of these caught and released steelhead trout were subsequent mortalities based on our estimate of the number of the juvenile steelhead caught and released by gear types and Taylor and White's (1992) estimates of hooking mortality by gear types. We estimated that 1,900 of these subsequent mortalities were age 1+ and 677 were age 2+ wild/natural steelhead trout parr based on our snorkel count estimates of the populations of the two age groups in Crooked River and our estimate of the relative vulnerability of the two age groups to angling. The estimated wild/natural steelhead trout parr fishing mortality in Crooked River for 1992 was 2,446 age 1+ and 2,623 age 2+ (Appendix C).

We estimated the 1992 pre-fishing season populations of wild/natural steelhead trout in Crooked River to be 22,410 age 1+ and 5,769 age 2+. Using these pre-fishing season population estimates, we estimated that 10.9% of the age 1+ and 45.5% of the age 2+ wild/natural steelhead trout populations in Crooked River were angler caused mortalities in 1992 (Appendix C).

Table 16. Density (number/100 m^2) of age 1+ and age 2+ steelhead trout parr in Crooked River, 1986 to 1992.

Stratum	1986	1987	1988	1989	1990	1991	1992
			Age 1+ steelhead trout				
Headwaters			1.5	0.2	0.4	0.1	0.1
I	6.8	4.3	5.2	1.9	0.2	0.7	3.9
II	11.7	10.8	8.8	4.4	1.5	7.3	10.5
Canyon			11.4	4.1	1.0	4.7	8.4
III	6.2	6.1	10.3	6.5	2.5	2.8	13.3
IV	7.2	7.2	7.5	3.4	1.5	3.7	11.4
Relief Creek			19.1	5.2	0.2	5.3	10.1
Ponds A[a]	4.8	42.4	17.8	7.2	1.2	0.6	3.4
Ponds B				10.1	0.1	1.7	8.3
5 Mile Creek	–						0.5
			Age 2+ steelhead trout				
Headwaters			0.2	0.3	0.1	0	<0.1
I	0.2	0.7	0.2	0.8	0.3	0.1	0.8
II	1.1	3.7	0.4	1.4	1.3	0.4	2.0
Canyon			1.2	2.1	1.2	0.4	2.2
III	0.2	2.8	0.5	1.8	1.4	0.1	2.4
IV	0.3	1.5	7.1	1.5	1.1	0.1	1.7
Relief Creek			0.6	1.8	0.1	0.5	2.4
Ponds A[a]	0.3	4.8	1.6	1.7	1.0	<0.1	1.2
Ponds B				2.2	0.3	0.2	0.8
5 Mile Creek							0

[a] In 1986-1988, the data for connected ponds was combined and is reported here as Ponds A.

TABLE16.92

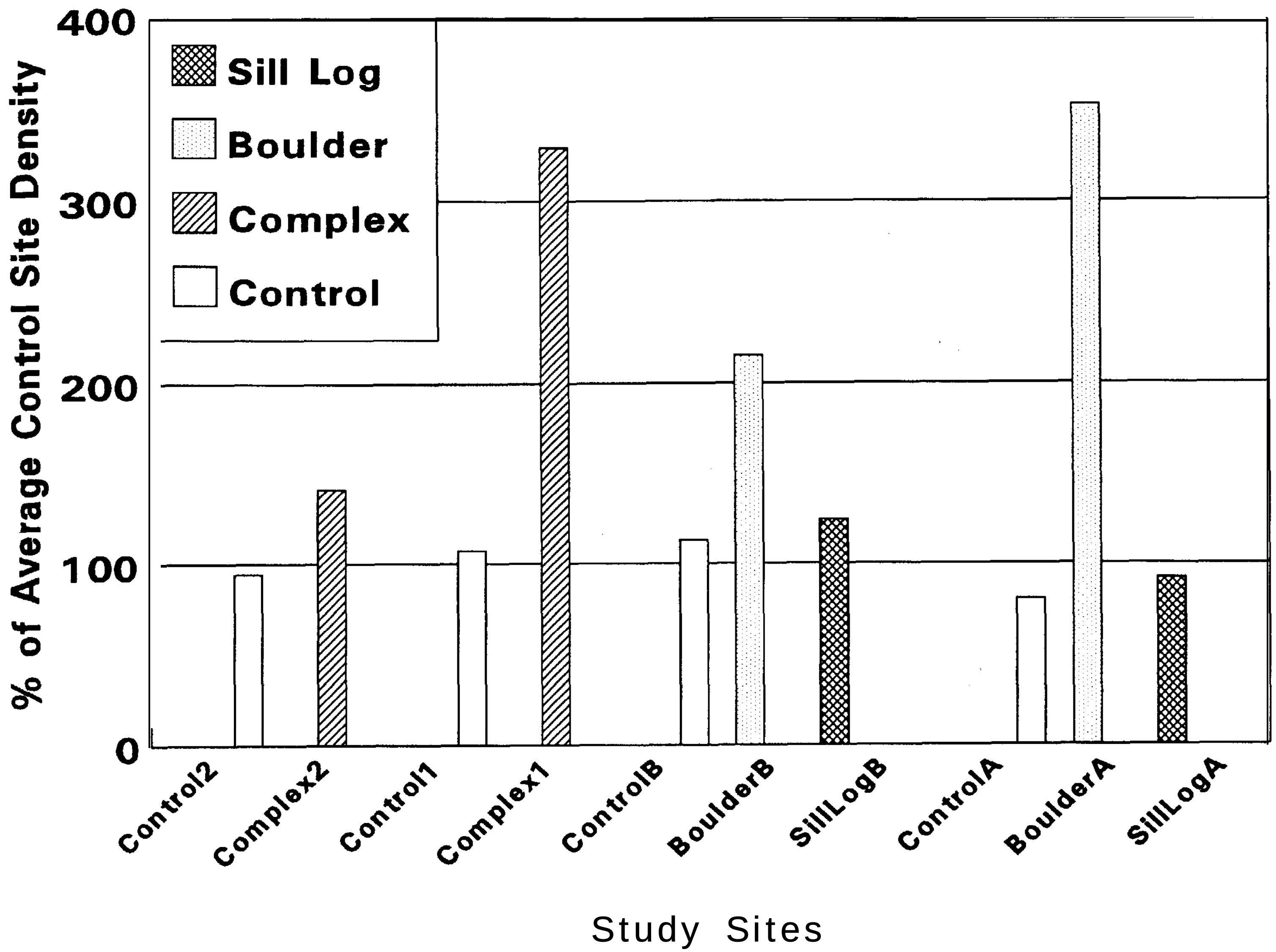

Figure 8. 1992 Crooked River upper meadow section age 1 + steelhead trout densities observed in control and habitat enhancement study sites.

PIT Tagging

During the first half of August, we collected and PIT tagged representative groups of chinook salmon and steelhead trout parr. We PIT tagged a total of 364 age 0 chinook salmon, 35 age 1+ chinook salmon, and 2,304 steelhead trout parr. The age composition of steelhead trout parr PIT tagged was; 9.5% (219) age 0, 65.5% (1509) age 1+, and 25.0% (576) age 2+ and older.

With the low abundance of chinook salmon age 0 parr, we were only able to collect and PIT tag two representative groups, each with fewer tagged fish than our goal. The number and groups of chinook salmon age 0 parr tagged were 148 in Relief Creek and 211 in Crooked River Stratum 2. For steelhead trout parr age 2+ and older the number tagged in each evaluation group was 62 in Relief Creek, 74 in Crooked River Stratum 1, 168 in Crooked River Stratum 2, 141 in Crooked River Stratum CAN, and 84 in Crooked River Stratum 3.

Combined collecting, PIT tagging, and 24-h delayed mortalities for August PIT tagging were 5.4% (20) for age 0 chinook salmon, and 1.3% (30) for steelhead trout parr.

Fall 1992 Emigration Trapping

During fall 1992, we operated a juvenile outmigrant trap on Crooked River to estimate chinook salmon and steelhead trout pre-smolt emigration. This trap was operated continuously from September 2 to November 11, 1992. We captured 97 chinook salmon pre-smolts with an estimated trapping efficiency of 17.8% (90% C.I.; 6.1-33.9%) and 449 steelhead trout juveniles with an estimated trapping efficiency of 8.7% (90% C.I.; 4.7-13.9%). We estimated that 545 (90% C.I.; 286-1,590) chinook salmon pre-smolts and 5,161 (90% C.I.; 3,230-9,553) steelhead trout juveniles emigrated from Crooked River. Age composition of steelhead trout juvenile emigrants based on trap captures was; 5% (258) age 0, 54% (2,787) age 1+, and 41% (2,116) age 2+ and older.

The estimated percentages of the Crooked River 1992 summer parr populations that emigrated in the fall were 131% of the age 0 chinook salmon, 14% of the age 1+ steelhead trout, and 53% of the age 2+ and older steelhead trout.

In fall 1992, both chinook salmon and steelhead trout juveniles had similar peaks of emigration from Crooked River (Figure 9). These peaks of fall 1992 emigration corresponded with increases in discharge (Figure 9).

Estimated Chinook Salmon Egg Deposition

The Crooked River adult chinook salmon run in 1992 began earlier than normal. The first adult was trapped on the May 15 and the largest portion (85%) of the run was collected at the trap between late May and early June. Typically, the peak arrival occurs in early July. A total of 121 adult males, 12 jacks, and 92 females were trapped during the season. The early arrival made visual sex determination difficult so our female to male ratio may not be accurate.

Nineteen fish (10 males, 2 jacks, and 7 females) were ponded at the Red River Satellite Facility, and later transported to the Clearwater Fish Hatchery due to high water temperature problems at Red River. Nine of these ponded adults died at the Clearwater Fish Hatchery prior to spawning (five males, one jack, and three females). There were three mortalities at the trap (one male, one jack, and one female). During July, several dead chinook salmon adults were found by

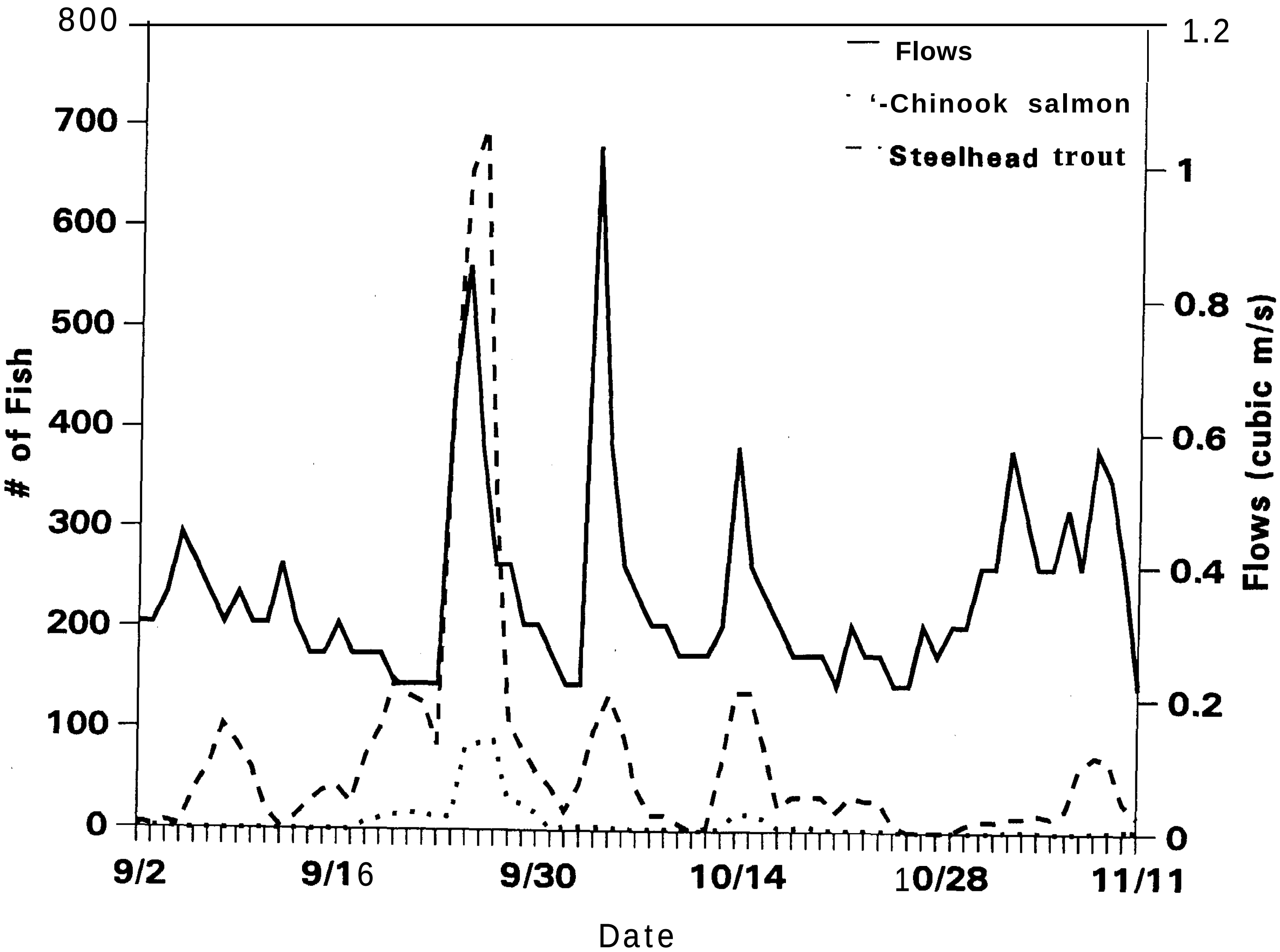

Figure 9. Fall 1992 Crooked River chinook salmon and steelhead trout emigration timing and flows (3 d moving average).

project personnel in Crooked River. These fish included four females with intact body cavities and few, if any, eggs.

On September 4, 1992, we conducted a ground survey for chinook salmon redds in the probable Crooked River spawning area. We observed 49 redds in Crooked River and 5 redds in Relief Creek. There were 27 live adult chinook salmon observed in Crooked River and 10 in Relief Creek. All live females observed were on redds. During our redd counts we observed three redds that appeared to be from early spawning chinook salmon. This suggests that some of the chinook salmon adults may have spawned in July.

We observed an average egg retention for successful spawners of 20 eggs per female. Hatchery personnel at the nearby Red River trapping facility estimated an average fecundity for chinook salmon of 3,825. Using this information we estimated a total chinook salmon egg deposition of 205,470 (Table 17).

Adult Chinook Salmon Outplants

In early August 1992, we erected a picket weir in Relief Creek approximately 100 m upstream of the Crooked River Road. We used this weir for our adult spring chinook salmon carrying capacity research. On August 25, one female and one jack were transported directly from the Crooked River adult trap and released upstream of the weir in Relief Creek. On August 28, four pair of adults that had been held at Clearwater Fish Hatchery were transported to Relief Creek and were mistakenly released below the weir. With the low flow conditions that existed in fall 1992, Relief Creek flowed underneath the dredge tailings just upstream of its confluence with Crooked River. This prevented the outplanted adult chinook salmon from leaving Relief Creek. We transported three more males to Relief Creek directly from the Crooked River adult trap on September 9. One was released above the weir and the other two were released below the weir near two females on redds. We observed one redd above the weir and four redds below the weir from the five females we released into Relief Creek.

Survival Rates

The BY 1991 chinook salmon egg-to-parr survival rate for the Crooked River Study Area was estimated to be 14.8%. Estimated BY 1991 steelhead trout egg-to-age 1+ parr survival rate for the Crooked River Study Area was only 0.9%.

We estimated the BY 1990 steelhead trout age 1+ to age 2+ parr survival for Crooked River to be 37.7%. This estimate was made by dividing the 1992 detection rate at the smolt collecting dams for age 1+ steelhead trout parr tagged in August 1990 (0.091 (27 of 296]) by the 1992 PIT tag detection rate for age 2+ steelhead trout parr tagged in August 1991 (0.242 [99 of 409]).

We estimated that parr-to-smolt (at the onset of smolt migration) overwinter survival in Crooked River was 48.2% for age 2+ and older steelhead trout. Because the few chinook salmon age 0 parr we PIT tagged in August 1991 were not representative of the population, we were not able to estimate overwinter survival this same way. However, we were able to use the same methodology comparing chinook salmon detection rates at the smolt collecting dams for fall 1991 and spring 1992 Crooked River chinook salmon emigrants to estimate a fall-to-spring overwinter survival of 46.3%. In 1990 and 1991, the summer-to-spring (parr-to-smolt) overwinter survival averaged 75% of the fall-to-spring survival rate. If we assume that the Crooked River chinook salmon parr-to-smolt overwinter survival for BY 1992 was 75% of the fall-to-spring survival, then we can estimate Crooked River chinook salmon parr-to-smolt survival to be 34.7% (46.3%/0.75 = 34.7%).

Table 17. Estimated chinook salmon adult escapement, redd counts, and number of eggs deposited in the Crooked River study area, 1985 to 1992.

	Chinook Salmon Brood Year							
	1985	1986	1987	1988	1989	1990	1991	1992
Female escapement.	16	14	27	43	15	95	5	88
Trend redd count	10	9	17	27	3			
Ground redd count				43	15	10[b]	4	54
Eggs per female[c]			4,010		4,400	4,200	4,400	3,805
Estimated eggs deposited (x1000)	67.54	59.09	108.27	181.50	66.00	399.00	17.60	205.47

[a] Female escapement was estimated for 1985-1987 based on 1:1 ratio of female escapement to ground redd counts observed in USR, and 43:27 ratio of ground to trend redd counts observed in 1988. Female escapement in 1988 and 1989 was assumed to equal the ground redd count. Pre-spawning mortality is included.

[b] Redd counts were conducted before 157 adult chinook (86 females) were outplanted into Crooked River from Dworshak National Fish Hatchery.

[c] Average number of eggs/female obtained from nearby Red River trapping facility minus average egg retention observed during ground redd counts.

The estimated survival, to the head of LGR pool, for parr PIT tagged in August 1991 was 32.8% for age 2+ and older eteelhead trout. Once again because the number of age 0 chinook salmon we tagged in August 1991 was too small and not representative of the population, we were unable to estimate survival for this group. For pre-smolts PIT tagged during the fall 1991 emigration, the estimated survival to the head of LGR pool was 15.8% for age 0 chinook salmon, and 37.3% for age 2+ and older steelhead trout. For smolts PIT tagged during the spring 1992 outmigration, the estimated survival to the head of LGR pool was 34.1% for chinook salmon and 68.1% for steelhead trout.

DISCUSSION

Spring 1992 Challis Remote PIT Tag Monitoring

We estimated that during the period the remote PIT tag monitor (monitor) was operating (April 29 to June 28, 1992) the survival of wild/natural chinook salmon smolts PIT tagged and released at our upper Salmon River emigrant trap site was 42%. However, this estimate was based on a small sample size (three detections at Challis) and our confidence interval for this survival estimate was wide (90% C.I.; 28-70%). The 106 km stretch of the Salmon River between our upper Salmon River emigrant trap site and the monitor site contains only a few small irrigation diversions, and human caused mortality in this stretch is probably minimal. In spring 1992 during this period, the Salmon River was experiencing extremely low flows as compared to normal flows and these low flows may have reduced the survival of chinook salmon smolts. Additionally, it must be noted that approximately 70% of the wild/natural chinook salmon smolt emigration from the upper Salmon River occurred before the irrigation season in the Challis area started and we began to operate our monitor.

Estimated Steelhead Trout Egg Deposition

Our experience has been that we are unable to collect accurate counts of steelhead trout redds in most years. Until a better method of determining spawning success is found we will use adult escapement and observed pre-spawning mortality in nearby hatcheries to estimate egg deposition.

Outplanting adult steelhead trout into the headwaters of the Salmon River and the upper meadow stretch of Crooked River initially appears to be successful. This initial assessment is based on the number of redds we did observe and the number of fry we observed in these areas during late summer.

PIT Tag Detections

Detections of PIT tagged smolts at LGR Dam allows us to determine migration characteristics of chinook salmon and steelhead trout smolts. As in previous years (Kiefer and Lockhart 1993), the majority of the total chinook salmon smolt run (predominately hatchery fish) arrived at LGR Dam earlier than the wild/natural chinook salmon smolts from Crooked River and upper Salmon River (Figure 10). This same timing has been observed for wild chinook salmon PIT tagged in the Middle Fork Salmon River drainage (Achord et al. 1993).

As in previous years (Kiefer and Lockhart 1993), the PIT tagged Crooked River and upper Salmon River wild/natural steelhead trout smolts peak arrival at LGR Dam occurred during the later portion of the peak arrival of all wild/natural steelhead trout smolts (Figure 11).

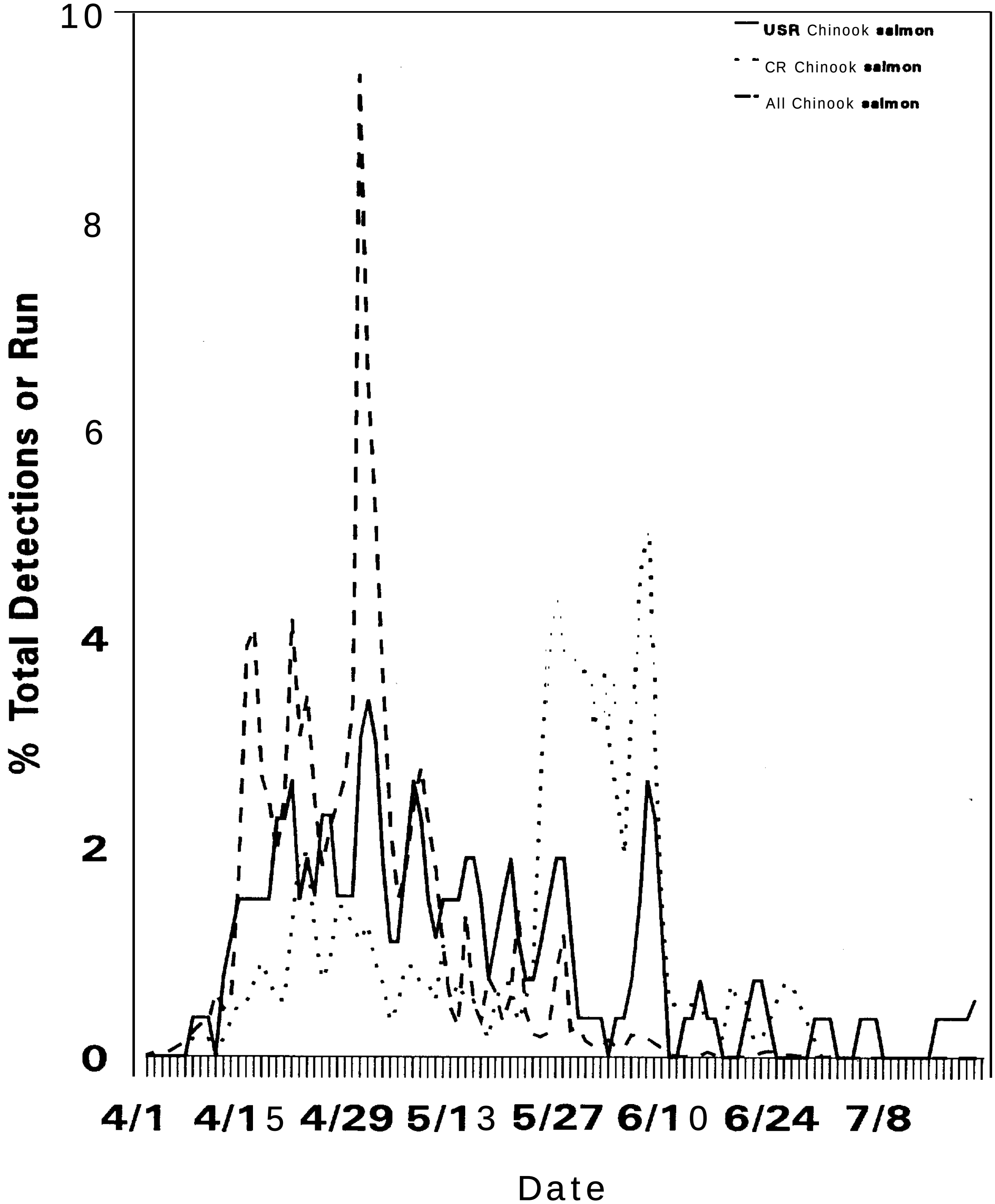

Figure 10. Arrival timing at Lower Granite Dam (3 d moving average) of all chinook salmon and PIT tagged chinook salmon from Crooked River and upper Salmon River 1992.

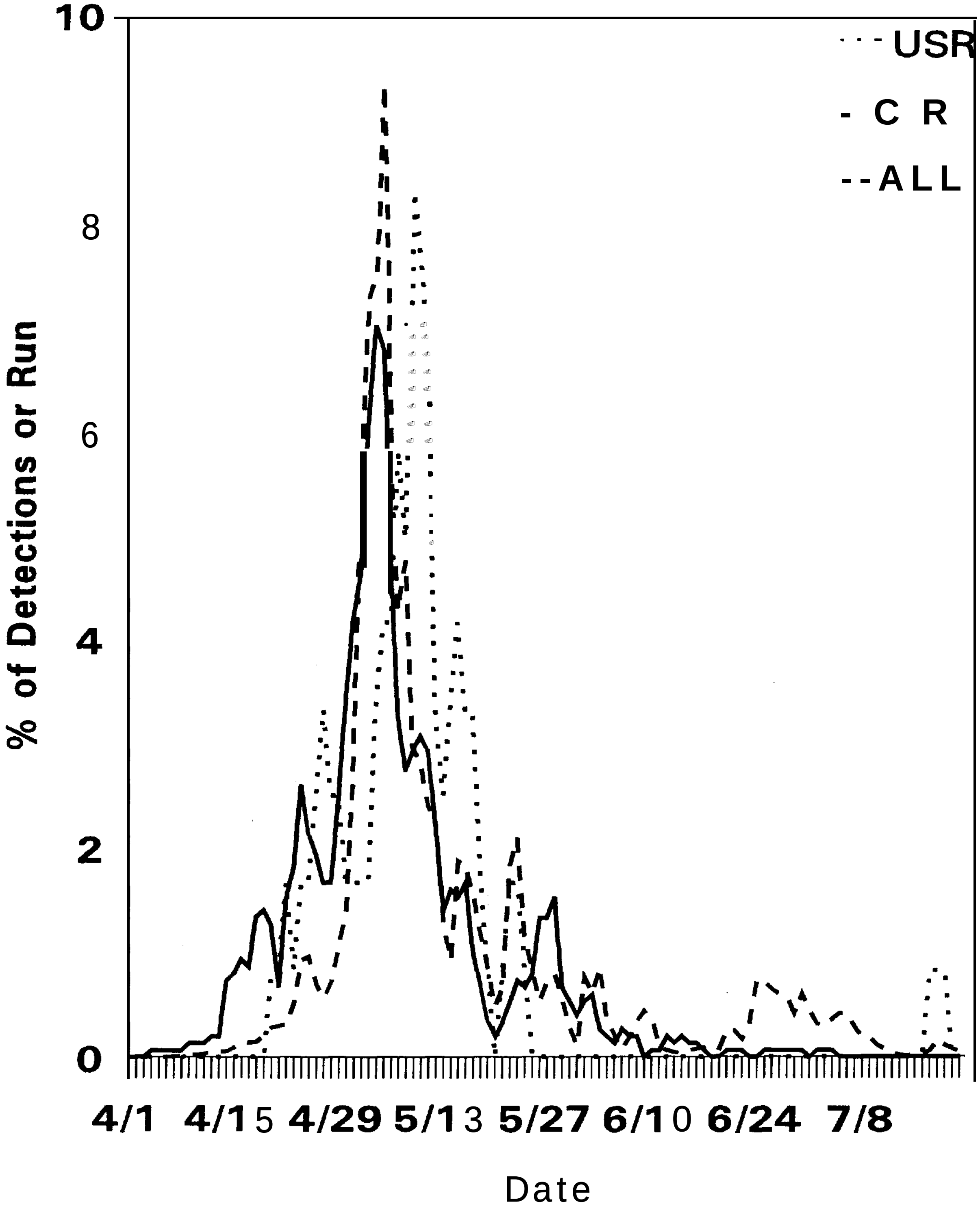

Figure 1 1. Arrival timing at Lower Granite Dam (3 d moving average) of all wild steelhead trout and PIT tagged steelhead trout from Crooked River (CR) and upper Salmon River (USR) 1992.

In 1992, we estimated that 37 PIT tagged Salmon River O. nerka smolts survived to the head of LGR pool and 11 of these 37 (29.7%) were detected, collected, and transported from LGR Dam. At Little Goose Dam, 10 of the possible remaining 26 (38.5%) were detected, collected, and transported. When the likelihood of mortality to some of these 26 O. nerka smolts passing through the turbines at LGR Dam (no spill in 1992) and Little Goose pool is considered, the data indicate that the collection facility at Little Goose Dam is more efficient at collecting O. nerka smolts than the facility at LGR Dam. We have observed similar detections of O. nerka smolts at these two smolt collecting dams in past years as well (Kiefer and Lockhart 1993).

Parr Abundance

As the chinook salmon and steelhead trout parr populations have declined during the past several years, so has our ability with our current methodology to estimate their abundance with a suitable level of accuracy and precision. Increasing effort with the current methodology to the level necessary to obtain adequate estimates would be cost prohibitive. Alternative methods for estimating parr abundance should be explored.

We believe that age 1+ steelhead trout densities approached carrying capacity in the lower four strata of Crooked River (mean = 10.9/100 m^2). This belief is based on the large number of adult steelhead trout we outplanted in 1991 (516 females), and similar age 1+ densities observed in 1986 and 1988 after adult steelhead trout outplants that included 1,363 (BY 1985) and 468 (BY 1987) females, respectively (Table 18). The canyon stratum had the lowest estimated density (8.4/100 m^2) out of the four strata and stratum three had the highest estimated density (13.3/100 m^2). The canyon stratum is where the river channel is confined between the road and the canyon wall in the "narrows", and pool habitat is limited in this stratum. Stratum 3 is the more "natural" part of the lower meadow section of Crooked River.

The more complex habitat rehabilitation structures (boulder and complex sites) in the upper meadow section of Crooked River increased age 1+ steelhead trout carrying capacity when compared with the control or simple sill log structure sites (Figure 8).

Crooked River Creel Survey

Our data indicate that anglers can have a major impact on wild/natural steelhead trout smolt production in streams with good road access and general fishing regulations (bait fishing allowed, no size limit, and a six-fish bag limit). In 1992, we estimated that 10.9% of the age 1+ and 45.5% of the age 2+ wild/natural steelheadtrout pre-fishing season populations in Crooked River were fishing mortalities (Appendix C). In 1990, we estimated that 62% of the Crooked River age 2+ natural steelhead trout population were fishing mortalities (Kiefer and Forester 1992). Other researchers in the region have reported levels of fishing mortality to age 2+ and older steelhead trout populations ranging from 23%-87% (Hillman and Chapman 1989; Pollard and Bjornn 1973; Thurow 1985 and 1987).

We believe that wild/natural steelhead trout parr populations in most juvenile rearing streams in the Snake River drainage have much lower fishing mortality than observed in Crooked River. Most of these wild/natural steelhead trout juvenile rearing streams do not have easy angler access like Crooked River. Also, most of the wild steelhead trout production streams and many of the natural production streams in Idaho are under restrictive regulations, catch-and-release or wild trout (2 fish limit). More of the natural production streams in Idaho

Table 18. Crooked River steelhead trout supplementation, summary by BYs 1986 to 1992.

	Brood Year						
	1986	1987	1988	1989	1990	1991	1992
Adult females	0	468	0	0	167	516	30
Fry	87,750	0	0	0	0	0	0
Fall parr	0	0	0	0	0	0	0
Smolts	158,538	201,325	88,000	214,633	0	0	

TABLE18.92

(including Crooked River) are planned to be under the wild trout regulation beginning in 1994.

Our estimates of fishing mortality impact apply to age 1+ and age 2+ parr populations and do not estimate impacts to smolt production. We will estimate the impact of 1992 fishing mortality to BY 1990 Crooked River steelhead trout smolt production (after age 2+) using 1993 PIT-tag detections at the lower Snake and Columbia rivers' smolt collecting dams. This estimated impact will be reported in our 1993 annual progress report. Likewise, using 1994 PIT tag detections at the smolt collecting facilities, we will be able to estimate the impact fishing mortality in 1992 had to BY 1991 Crooked River steelhead trout smolt production after they had reached age 1+; this impact will be reported in our 1994 annual progress report.

PIT Tagging

We PIT tagged sufficient numbers of age 0 chinook salmon part in three upper Salmon River evaluation groups to adequately estimate detection rates at the Snake and Columbia rivers' smolt collecting dams. In one other upper Salmon River evaluation group, we tagged enough age 0 chinook salmon for a fair estimation. The Crooked River age 0 chinook salmon densities were too low for efficient collecting. We were only able to PIT tag two evaluation groups in Crooked River with fair-poor numbers for estimating detection rates at the smolt collecting dams.

For age 2+ and older steelhead trout parr the results were opposite of chinook salmon. Age 2+ and older steelhead trout densities in the upper Salmon River were so dismal that we were able to collect and PIT tag only enough for one poor evaluation group. In Crooked River, we were able to PIT tag enough age 2+ and older steelhead trout for two good, two fair, and one poor evaluation group. In Crooked River, we were able to PIT tag over 1,500 age 1+ steelhead trout parr that should provide us with a good estimate of age l+-to-age 2+ survival once they are detected at the smolt collecting dams in spring 1994.

In all years (1988-1992), we have PIT tagged in both study areas, the length of naturally produced age 0 chinook salmon from the upper Salmon River (average = 79.2 mm; 90% C.I.; 77.6-80.8 mm) has been significantly larger than that from Crooked River (average = 69.6 mm; 90% C.I.; 66.2-73.0 mm). This is contrary to what elevation and thermal units for growth would predict. Two possible explanations for differences in growth are the higher conductivity (more productivity - Lind 1979) in the upper Salmon River and genetic differences in stocks.

Combined collecting, PIT tagging, and 24-h delayed mortalities were well below 5%, except for Crooked River age 0 chinook salmon whose combined mortality was 5.4%. Most of these Crooked River chinook salmon mortalities (17 of 20) were all 24-h delayed mortalities within one tag file. We do not know what caused this high rate of 24-h delayed mortality in this one tag group. These fish were collected by beach seine and the tagging temperature was below 15°C.

PIT Tagged Delayed Mortality Study

The results of our delayed mortality study indicate that chinook salmon parr PIT tagged in August and returned to their natural rearing habitat do not suffer significantly higher mortality than either caudal-nipped only or unhandled chinook salmon parr when sampled in October. The potential biases of underestimating the number of un-handled chinook salmon parr with snorkel counts, and the probable immigration of unmarked parr both would bias the results towards higher survival of the un-handled parr. Even with these two probable biases we *were* unable to detect a significant difference in the survival between any of the groups.

A concern with PIT tagging chinook salmon stocks threatened with extinction is the possible lateral transfer of disease, especially BKD. In our PIT tagging operations, we use individual hand held injectors which are sterilized for a minimum of 10 min in 70% ethanol between successive taggings. The data we collected in this study indicates that at the end of October we did not cause significant increase in mortality or external visual symptoms of BKD when we PIT tagged in August.

Our current study in a stream environment and data from hatchery studies (Prentice et al. 1986; Kiefer and Forster 1990) indicates that PIT tag loss or failure is not a significant problem. Of the 305 August PIT tagged chinook salmon parr we recaptured in October during the 2 years of this study, we observed no tag loss and only one tag failure.

The caudal nip we used to externally mark chinook salmon parr in August was 100% readable in October. This mark detection rate is based on the fact that we did not find any chinook salmon parr in October with working PIT tags in them from this study without first identifying them as having the correct caudal nip. Further evaluation is needed to determine if this mark can be identified over a longer period, and if it can be used to successfully mark chinook salmon fry.

Fall 1992 Emigration Trapping

There are three possible explanations for us estimating that 100% of the Crooked River summer 1992 age 0 chinook salmon emigrated during fall 1992: 1) our snorkel count methodology underestimated the parr abundance; 2) we overestimated the fall emigration; and, 3) there was a significant immigration of age 0 chinook salmon from the South Fork Clearwater River into Crooked River after we conducted our snorkel counts.

We believe the most likely explanation is that our snorkel count methodology underestimated the chinook salmon parr population. To test this belief, we used our fall trap captures of age 0 chinook salmon (97), our fall trap recaptures of August PIT tagged age 0 chinook salmon (12), and the total number of PIT tagged age 0 chinook salmon released in August (344) in a Ricker (1975) adjusted Peterson estimate. With this method, we estimated Crooked River summer chinook salmon abundance to be 2,601 (90% C.I.; 1,438-3,764). We believe this estimate to be more accurate.

If we use 2,601 as the estimate of Crooked River age 0 chinook salmon abundance, we can then estimate that approximately 21% of the Crooked River summer 1992 age 0 chinook salmon population emigrated in the fall. This estimate of the percentage of the Crooked River summer age 0 chinook salmon population that emigrated in the fall (21%) is very close to the average percent fall emigration (24%) we have estimated for Crooked River chinook salmon during the past 3 years (Kiefer and Lockhart 1993).

Estimated Chinook Salmon Egg Deposition

The peak of the 1992 adult chinook salmon run into Crooked River was approximately 1 month earlier than previously observed. This was probably a result of the very early and warm spring in 1992. We observed evidence of a few Crooked River adult chinook salmon spawning in July (spawned out female carcasses in July and chinook salmon redds in early September with periphyton regrown).

The remainder of the redds discovered in September appeared to be constructed much more recently.

We counted 54 redds that were produced from the 88 female and 118 male chinook salmon released above the weir to spawn naturally or outplanted into Relief Creek. If we assume a 1:1 female:redd ratio, then Crooked River chinook salmon only had a 61% spawning success rate in 1992. While conducting our snorkel counts, we observed terminal fishing tackle typically used in snagging salmon in two different locations of Crooked River indicating that an unknown number of adult chinook salmon may have been removed illegally.

Apparently chinook salmon spawning in the upper Salmon River was not completed when we conducted our redd counts during the first 3 d of September. We observed several live females in good condition in areas without redds. IDFG Regional personnel also concluded (Jim Lukens, personal communication) that spawning was not completed in the upper Salmon River after conducting aerial redd counts on September 3. Therefore, we used the previous 5 year average of adult chinook salmon pre-spawning mortality observed at Sawtooth Fish Hatchery to estimate the number of females that successfully spawned.

Survival Rates

Estimated BY 1991 chinook salmon egg-to-parr survival was the highest we have estimated for both the upper Salmon River headwaters (38.2%) and the entire upper Salmon River (12.9%). A possible explanation for this higher egg-to-parr survival may be a result of the mild 1991-92 winter and early spring and summer in 1992. The mild winter reduces the amount of anchor ice and the mild winter and early spring and summer likely results in chinook salmon embryos receiving more daily thermal units for growth and spending less time in the gravel before emergence.

We have consistently estimated greater chinook salmon egg-to-parr survival from redds constructed in the headwaters of upper Salmon River than in the entire upper Salmon River (tables 12 and 13). We theorize that at least two factors are contributing to this difference. First, the low gradient, meandering headwater streams are probably better chinook salmon rearing habitat than the fast runs that are the predominant habitat in the mainstream of the upper Salmon River. Second, based on a study in 1991 (Kiefer and Lockhart 1993), more than half (55%) of the fry produced in the mainstream were estimated to emigrate out of the study area immediately after swim-up.

Estimated BY 1991 chinook salmon egg-to-parr survival for Crooked River (14.8%) was within the range we have estimated there in the past (9.4-15.0%). However, four out of five of the BY 1991 chinook salmon redds observed in Crooked River were in our Relief Creek adult outplant site. Approximately 25 head of cattle from a grazing allotment on Deadwood Summit were observed in the Relief Creek adult chinook salmon outplant site soon after spawning was completed. U.S. Forest Service personnel contacted the permittee and the cattle were removed after 5 d. The cattle seemed to select the same areas to cross Relief Creek as the chinook salmon had selected to spawn in. It is possible that these cattle reduced the survival of the BY 1991 chinook salmon embryos deposited in Relief Creek.

Estimated BY 1990 steelhead trout egg-to-age 1+ parr survival in both study areas was too low to produce self sustaining populations (1.3% in upper Salmon River and 0.9% in Crooked River). We attribute the low estimated survival in Crooked River to our outplant of adults from DNFH and outplant locations. We outplanted approximately twice as many adults as we estimate it would take to fully seed Crooked River. Also, most of these adults were mistakenly outplanted into the lower meadow section instead of being released throughout the drainage as planned. Data we collected in 1991 (Kiefer and Lockhart 1993) indicated that (DNFH) adults were not real successful at spawning (23% female pre-spawning mortality and 21% egg retention in successful spawners). Finally, with most of the redds being constructed in the lower meadow section of Crooked River at densities exceeding carrying capacity, a large percentage of the juvenile steelhead trout produced probably emigrated out of Crooked River before we could count them as age 1+ parr in July 1992.

For upper Salmon River steelhead trout, we believe there are four factors contributing to our low estimate egg-to-parr survival. These four factors are: 1) the Snake River A-run steelhead trout stock used to start the Sawtooth Fish Hatchery program may not have been a good habitat match for the upper Salmon River, 2) the majority of the steelhead trout redds observed in upper Salmon River are in the first 10 km above the weir where the predominant habitat type is fast runs, and many of the juvenile steelhead trout probably emigrate out of the study area before we can count them, 3) our snorkel count methodology of estimating parr abundance is apparently not very accurate when populations are at such low levels, and 4) we have observed an increasing incidence of visual signs of whirling disease (dolphin shaped heads, dark caudal peduncles, and whirling behavior) in upper Salmon River steelhead trout parr.

Estimated chinook salmon parr-to-smolt survival (mean = 18.7%; 90% C.I.; 17.2-20.1%) from the upper Salmon River has been fairly consistent for all years studied (BY 1989-92), but lower than expected. The Crooked River chinook salmon parr-to-smolt survival was low during BYs 1989 and 1990 (12.3% and 13.0%) but was significantly higher during BYs 1991 and 1992 (36.3% and 34.7%). We believe the higher survival for Crooked River during BYs 1991 and 1992 can be attributed to the cessation of chinook salmon hatchery fry outplants [parr produced from hatchery fry outplants do not perform as well as wild/natural parr (Kiefer and Forster 1992)]. We believe the Crooked River chinook salmon parr-to-smolt survival estimates for BYs 1991 and 1992 (36.3% and 34.7%) are fairly accurate for Crooked River naturally produced chinook salmon. We believe the upper Salmon River chinook salmon parr-to-smolt survival estimates for BY 1989-92 (mean = 18.7%) are accurate for upper Salmon River naturally produced chinook salmon during these years. Possible reasons for the lower upper Salmon River chinook salmon parr-to-smolt survival include disease problems or a lack of suitable overwinter habitat.

Estimated BY 1992 age 2+ to smolt (at the onset of migration) survival for steelhead trout was 48.2% for Crooked River and only 10.2% for upper Salmon River. We believe these estimates to be fairly accurate and indicate that there is a survival problem for upper Salmon River steelhead trout. Estimated age 2+ to smolt (at the onset of migration) survival for upper Salmon River steelhead trout has decreased for each successive year studied and were; 54.8% for BY 1988, 48.0% for BY 1989, 24.7% for BY 1990, 14.4% for BY 1991, and 10.2% for BY 1992. A possible explanation for this decreasing trend in survival is the increased number of juvenile steelhead trout in upper Salmon River we have observed with symptoms of whirling disease.

RECOMMENDATIONS

1. Our creel survey on Crooked River revealed that fishing mortality was large on wild/natural steelhead trout juveniles under Idaho's general trout regulations in a stream that had good angler access. We recommend that in streams with easy angler access and wild/natural steelhead trout populations it be determined if increases steelhead trout smolt production can be obtained with fishing regulation changes.

2. We recommend that simple sill log structures not be used for habitat enhancement projects. Our data indicated that more complex habitat

structures increased age 1+ steelhead trout carrying capacity while simple sill log structures did not.

3 Our survival estimates and adult returns at Sawtooth Fish Hatchery indicate that Sawtooth Fish Hatchery adult steelhead trout released immediately above the weir are not producing a self sustaining natural population under current survival conditions. We recommend research on kelt reconditioning to determine if they can be used as brood stock. If kelt reconditioning is viable, other wild populations, such as Middle Fork Salmon River steelhead trout, could be used to supplement the upper Salmon River population without impacting (by removal) the wild donor stock.

4 We recommend further work be conducted to eliminate adult and juvenile passage problems associated with irrigation diversions in the upper Salmon River. Complete dewatering of some tributary streams (Fourth of July, Champion, Williams, Fisher, and Beaver creeks) during summer and early fall prevent adult chinook salmon from reaching spawning areas where we have estimated better egg-to-parr survival. All of these streams have unscreened diversions, and we have observed chinook salmon and steelhead trout parr in all of these streams except Williams and Fisher creeks. In all probability, juvenile chinook salmon and steelhead trout are being lost in the fall as approximately 60% attempt to emigrate downstream to overwinter.

5. We recommend the modification of two irrigation diversions on the Salmon River so that remote PIT tag monitors can be operated outside of the normal irrigation season. One of these diversions should be located upstream of Challis, Idaho and the other one downstream of Salmon, Idaho. These monitors would allow researchers working upstream of the town of Salmon to estimate wild/natural and hatchery emigrant migration and survival rates and determine overwintering locations for fall emigrants. This option would be less expensive, cause less mortality to the fish, be more reliable, and would provide better data than operating emigrant traps in the same areas.

6. We recommend determining if PIT tag mark/recapture data can be used to more accurately and precisely estimate juvenile anadromous fish populations than our current snorkel count methodology.

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A P P E N D I C E S

Appendix A. July 1992 upper Salmon River parr abundance estimates and confidence intervals (a = 0.10).

Stream/Strata	Area (m^2)	Age:0 Chinook	Age:1+ Steelhead	Age:2+ Steelhead
Salmon River				
SR-3/4	412,436	14,021 ± 20,838	587 ± 1,113	43 ± 82
SR-5/6	145,042	592 ± 783	0	0
SR-7	67,071	42 ± 263	0	0
SR-8	46,575	24 ± 149	0	0
SR-9/10	54,799	0	0	169 ± 246
Stream Total	725,923	14,679 ± 19,232	587 ± 1,113	212 ± 221
Salmon River Side Channels				
SR-3/4	35,598	6,796 ± 7,653	18 ± 42	60 ± 97
SR-5/6	5,892	0	0	0
SR-7/8	10,296	90 ± 151	0	0
Stream Total	51,786	6,886 ± 6,555	18 ± 42	60 ± 97
Gold Cr.	2,210	0	0	0
Huckleberry Cr.	2,505	334 ± 1,386	0	0
4th of July Cr.	15,453	625 ± 2,542	23 ± 138	104 ± 473
Champion Cr.	8,246	0	0	0
Alturas Lake Cr.				
ALC-1	36,703	15 ± 21	0	0
ALC-2	11,747	98 ± 61	0	13 ± 14
ALC-3	16,506	1,060 ± 708	23 ± 64	8 ± 21
ALC-4	94,767	222 ± 1,378	0	0
ALC-5	58,944	0	0	0
ALC-Tribs [a]	26,356	1,297 ± 1,763	0	9 ± 26
Stream Total	245,023	2,692 ± 1,302	23 ± 64	30 ± 25

APPENDA.92

Appendix A. Continued

Stream/Strata	Area (m^2)	Age:0 Chinook	Age:1+ Steelhead	Age 2+ Steelhead
Pole Cr.				
PC-1	16,419	0	74 ± 33	0
PC-2	18,775	0	57 ± 33	0
PC-3	16,926	0	0	0
PC-4/5	24,234	0	0	52 ± 119
Stream Total	76,354	0	131 ± 18	52 ± 119
Smiley Cr.	29,559	0	0	0
Beaver Cr.	47,114	0	0	0
Frenchman Cr.				
FC-1	3,218	0	0	0
FC-2	24,998	19,838 ± 29.798	0	0
Stream Total	28,216	19,838 ± 29,798	0	0
Study Area Total	1,232,389	45,054 ± 30,498	782 ± 976	458 ± 270

[a] Yellowbelly Lake Creek and Petit lake Creek combined.

APPENDA.92

Appendix B. July 1992 Crooked River abundance estimates and confidence intervals (a-0.10).

Stream/Strata	Area (m^2)	Aae 0 Chinook	Age 1+ Steelhead	Aae 2+ Steelhead
CR-HDW	71,579	0	89 ± 186	26 ± 54
CR-1	36,183	0	1,423 ± 636	277 ± 260
CR-2	37,435	236 ± 256	3,933 ± 2,424	761 ± 402
CAN-1	62,275	31 ± 89	5,258 ± 3,444	1,366 ± 622
CR-3	27,655	36 ± 100	3,675 ± 1,505	671 ± 120
CR-4	29,493	29 ± 79	3,361 ± 1,665	489 ± 58
RC-1	4,320	74 ± 40	517 ± 908	154 ± 120
RC-2	6,008	0	479 ± 610	72 ± 318
PND-A	2,999	9 ± 15	102 ± 116	36 ± 39
PND-B	20,037	0	1,669 ± 1,287	169 ± 242
5MC	593	0	3 ± 13	0
Study area total	298,576	415 ± 213	20,528 ± 3,221	4,021 ± 565

APPENDB.92

Appendix C. Estimation of fishing mortality of age 1+ and age 2+ wild/natural steelhead trout in Crooked River in 1992.

		Age 1+	Age 2+
1.	Harvest up to 7/12/92	5 1 8	1,262
2.	Release up to 7/12/92	9,507	3,392
3.	Catch and release hooking mortality		
	Bait	1,118	399
	Lure	91	32
	Fly	155	55
	TOTAL	1,364	486
4.	Total fishing mortalities to 7/12/92 (#1 + #3)	1,882	1,748
5.	Population estimate from snorkel data taken on 7/12/92	20,528	4,021
6.	Pre-season population estimate' (#4 + #5)	22,410	5,769
7.	Seasonal harvest	546	1,946
8.	Seasonal catch and release	13,236	4,723
9.	Seasonal catch and release hooking mortality		
	Bait	1,557	555
	Lure	127	45
	Fly	216	77
	Total catch and release mortality	1,900	677
10.	Seasonal fishing mortality (#7 + #9)	2,446	2,623
11.	Seasonal fishing mortality (%) [(#10/#6) x 100)]	10.9	45.5

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